

**ECONOMIES OF SCALE IN INTERNATIONAL LINER SHIPPING AND
ONGOING INDUSTRY CONSOLIDATION: AN APPLICATION OF STIGLER'S
SURVIVORSHIP PRINCIPLE**

by

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**Economies of Scale in International Liner Shipping and Ongoing
Industry Consolidation: An Application of Stigler's
Survivorship Principle**

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(ABSTRACT)

The international liner shipping industry has been undergoing major structural changes caused by a number of factors. Liner companies have responded to these challenges by engaging in mergers and acquisitions and by forming global strategic alliances. Many of these organizational changes have reportedly been undertaken to achieve, among other things, economies of scale. This paper systematically addresses two questions — whether there are economies of scale in international liner shipping, and if so, what are the implications of those economies for industry structure.

To determine whether scale advantages exist, George Stigler's "Survivorship Principle" is used with current data in three phases. All three phases of the study show that increasing returns to scale are present. In each application of the survivorship test, small and medium sized firms experienced significant decline in their share of the industry's capacity, while the largest firms continued to gain market share over the 20-year test period. The existence of economies of scale at both the firm and plant level is most pronounced during the shorter 1987-1997 period, subsequent to significant regulatory changes.

The study empirically verifies that economies of scale in liner shipping have been increasing in response to technology-driven productivity growth, regulatory changes, and higher world-wide trade flows. The pursuit of economies of scale also appears to be contributing to the consolidation occurring in the industry today via both mergers and acquisitions, and the formation of global strategic alliances. Lastly, the study discusses the implications of economies of scale on firm structure within the context of current industry economics, and evaluates business strategies presently being pursued.

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ABBREVIATIONS

| | |
|---------------|--------------------------------------|
| APL | American President Lines, Ltd. |
| Cho Yang | Cho Yang Shipping Co. Ltd. |
| COSCO | China Ocean Shipping Company |
| CP Ships | Canadian Pacific Ships |
| DSR/Senator | DSR/Senator Lines, GmbH |
| Evergreen | Evergreen Marine Corp. (Taiwan) Ltd. |
| Hanjin | Hanjin Shipping Company Ltd. |
| Hapag Lloyd | Hapag-Lloyd Containerlinie GmbH |
| Hyundai | Hyundai Merchant Marine Co., Ltd. |
| K-Line | Kawasaki Kisen Kaish Ltd. |
| Lykes | Lykes Lines Ltd., LLC |
| Maersk | A. P. Moller-Maersk |
| Med. Shipping | Mediterranean Shipping Co. SA |
| MOL | Mitsui-OSK Lines Ltd. |
| Nedlloyd | Nedlloyd Lines |
| NOL | Neptune Orient Lines Ltd. |
| NYK | Nippon Yusen Kaisha |
| P&O | P&O Containers Ltd. |
| Sea-Land | Sea-Land Service, Inc. |
| TEUs | Twenty-foot Equivalent Units |
| Yangming | Yangming Marine Transport Corp. |

CHAPTER I

INTRODUCTION

1.1 Background and Scope

It seems that almost daily, the headlines are filled with reports about the formation of cooperative alliances or mergers/acquisitions among one or more firms in a particular industry on a national or international level. Alliances may range from relatively informal, short-term, project-based cooperation to more formal, ongoing, equity sharing joint ventures. Over the last two decades, strategic alliances and other forms of inter firm cooperation have been used with greater frequency to restructure industries, keep pace with rapidly changing technologies, and address the problems of global production and excess worldwide capacity. Moreover, by linking up with another firm, one or more of the partners may gain options otherwise unavailable to them, such as better access to markets, pooling or swapping technologies and information, enjoying larger economies of scale and benefitting from economies of scope.¹

Like other transportation industries, international container² shipping has been undergoing major structural changes for several years. All ocean liner³ companies ("carriers" or

¹Farok J. Contractor and Peter Lorange, "Why Should Firms Cooperate? The Strategy and Economic Basis for Cooperative Ventures," *Cooperative Strategies in International Business* (Lexington, MA: Lexington Books, 1988) p 5.

² Liner service, since the 1970s, increasingly has handled cargo loaded in standard-sized metal containers, and is therefore also known as "container" service. See for example, Federal Maritime Commission, *Section 18 Report on the Shipping Act of 1984* (Washington DC: U.S. Government Printing Office, 1989) 46-50 [hereinafter FMC Section 18 Report], and *Report of the Advisory Commission on Conferences in Ocean Shipping* (Washington, DC: U.S. Government Printing Office, 1992) 9-10 [hereinafter ACCOS Report].

³ The Shipping Act of 1984, as amended, deals exclusively with the regulation of the liner or common carrier shipping segment of the international ocean shipping industry. 46 U.S.C. sections 1701-1721 (1994). Liner services differ from "charter" or "tramp" services in that they operate on a regular schedule, on fixed trade routes and are available to the general public. The prices (freight rates) charged are based on either the carrier's own or a rate-setting conference's published tariff. Charter or tramp ocean carriers operate in totally unregulated markets, do not necessarily provide regularly scheduled service or hold themselves out to the general public. They usually carry specialized cargo (e.g., coal, oil, and lumber) in large volumes (bulk) for the account of single shippers. See generally, Jan Owen Jansson and D. Shneerson, *Liner Shipping Economics* (London: Chapman & Hall, 1987), Allen R. Ferguson et al., *The Economic Value of the United States Merchant Marine* (Evanston, IL: Transportation Center, Northwest

“container operators”) are being driven by the same fundamental forces: the ongoing globalization of manufacturing, technological innovations (especially those that support vertical integration of transportation services, e.g., electronic communications, automated data systems, larger/faster vessels, etc., which allow economies of scale and scope), intense competition and low margins, development of global service networks, deregulation and privatization, and industry consolidation. At the firm level, carriers have responded to these pressures by engaging in a rash of mergers and acquisitions and by forming a number of global strategic alliances. At the plant or vessel level, the average vessel size has dramatically increased as well. Many of these organizational changes have reportedly been undertaken to achieve, among other things, economies of scale at both the firm and plant (vessel) level.

While cooperation among carriers has been common for more than a century -- especially through arrangements known as "conferences"⁴ -- the creation over the last five years of multi-national, multi-trade strategic alliances involving substantial asset sharing and operational cooperation has dramatically shifted the scope and the structure of traditional forms of ocean carrier cooperation. Broadly stated, the purpose of these partnerships is for a small group of carriers (currently ranging from two to four) to establish operational cooperation, while maintaining individual marketing and commercial identities.

Since 1994, nearly all principal global containership operators have grouped themselves into alliances. Through operational cooperation, carriers have the opportunity to reduce costs and business risks, while offering improved service, increased sailing frequency, increased direct port calls, and a broader range of customer service options. Cooperation is on a multiple trade lane (global) basis and generally includes sharing vessels, coordinating sailing schedules, jointly using port terminals, sharing equipment, and combining information technologies associated with operational matters.

University, 1961), and Daniel Marx, Jr., *International Shipping Cartels: A Study of Industrial Self-Regulation by Shipping Conferences* (Princeton: Princeton University Press, 1953).

⁴ Conferences are agreements among ocean liner carriers that restrict competition by setting prices, rationalizing sailing schedules and ports of call, and sometimes pool cargo or revenue. FMC Section 18 Report, Note 2, p 23. Conference agreements, as well as other types of ocean carrier agreements, are exempt from the traditional U.S. antitrust laws.

Some carriers have chosen to venture beyond alliances and have engaged in mergers or acquisitions that increase their size and expand their scope of operations. Since 1995, 7 principal mergers and more than 25 acquisitions have taken place. Another growth strategy has been to acquire or merge with selected carriers while maintaining participation in a global strategic alliance. Still other carriers have elected to primarily grow on their own by expanding operations internally.

1.2 Purpose and Significance

The pursuit of economies of scale in liner shipping has been cited as a major reason behind carriers' motivation to recently form strategic alliances, engage in mergers and acquisitions, and their relentless efforts to individually amass huge vessel fleets and increase vessel (plant) capacity by building larger ships.⁵ However, several economic studies present rather mixed evidence as to whether the liner industry is characterized by significant economies of scale, that is, whether the unit cost of production (per unit of cargo transported) declines markedly as the size of the firm increases. More recent studies contend that technological advancements have caused the industry to tend towards increased scale, scope and network economies requiring an increase in the efficient firm size. Other, more dated studies, conclude that while economies of scale are present, constant returns to scale are the rule for a wide range of firms.

The purpose of this paper is to address two central questions. First, are there economies of scale in liner shipping? Second, if there are, what are the implications of those economies for the structure of the industry, and in particular, the nature of the firms operating in it? The analysis is important because there have been no recent attempts to systematically test whether and to what extent scale economies exist in liner shipping at the firm

⁵The average container ship size increased by two-thirds from 955 TEUs in 1980 to more than 1,600 in 1996. Vessels capable of loading 4,000 TEUs or more accounted for 60% of the orders placed for new buildings in 1998, with the largest vessels in service reaching over 6,000 TEUs. Source: various issues of *Containerisation International*.

level using current data sources.⁶ The analysis is also important because the information developed will add to the literature and our understanding of why carriers have been motivated to increase their relative size by forming strategic alliances and engage in mergers and acquisitions.

1.3 Organization and Approach

Chapter I provides a brief introduction including the purpose, scope, and overall organization and approach of the paper. Chapter II includes an analysis of, and comparisons among, a number of previous studies of the existence and extent of economies of scale in liner shipping. It is important to point out that most of these studies were undertaken in the context of policy questions concerning whether liner shipping should be allowed to continue to be granted antitrust immunity. This paper has a different focus: what such economies may mean for industry structure. It will not address antitrust or other policy implications. The literature reviewed also covers a considerable period of time (the last 80 years) and use different data sets from different periods during which the technologies used in the industry changed dramatically. Consequently, these studies and their results will be presented chronologically to highlight differences attributable to historical changes and technological innovations.

To determine whether scale advantages exist in liner shipping, Chapter III employs George Stigler's "Survivorship Principle," a simple, yet powerful method for estimating the optimal firm size in an industry. Current liner shipping data is used in three phases. First, the data is analyzed using Stigler's basic Survivorship approach. This includes an analysis of the distribution of liner shipping capacity over time, by both relative firm size and vessel (plant) size. Second, the data is used more extensively to update a 1960 study that employed Stigler's Survivorship Principle to measure the extent of economies of scale in liner shipping. Third, data on a subset of liner firms is analyzed within the context of Stigler's Survivor method.

Chapter IV discusses the implications of economies of scale on firm structure within the

⁶ A few recently published studies investigate whether economies of scale in liner shipping exists at the vessel (plant) level. Some of these studies present evidence and arguments that support economies of scale at the vessel (plant) level. See for example: Drewry Shipping Consultants, *Post-Panamax Containerships: 6000 TEU and Beyond*, September 1996; and Seok-Min Lim, "Economies of scale in container shipping," *Maritime Policy Management*, Vol. 25, No. 4 (1998) 361-373.

context of current industry economics and examines business strategies presently being pursued. Various alternative business strategies (growth options) are presented and the pluses and minuses of each option are evaluated.

CHAPTER II
LITERATURE REVIEW ON ECONOMIES OF
SCALE IN LINER SHIPPING

2.1 Literature Review

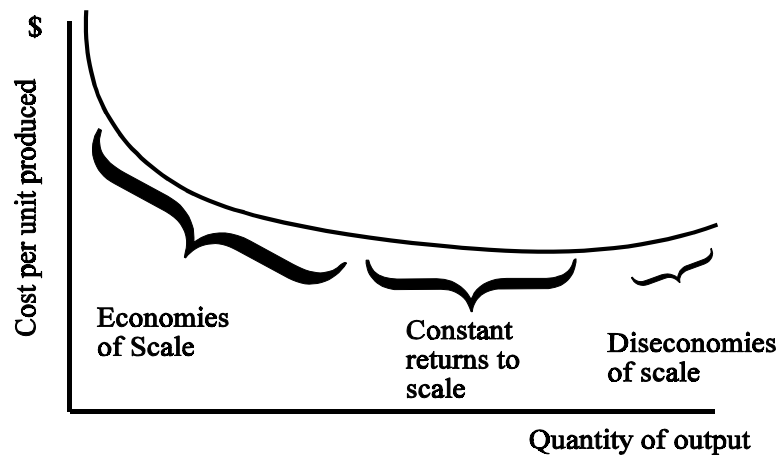
2.1.1 Scale Economies:⁷ The relationship between a firm's long-run average cost and its level of output follows either of three cost patterns. Its long-run average cost may stay the same as the quantity of output changes resulting in *constant returns to scale*. This occurs, for example, if output doubles when all inputs are doubled. If the firm's long-run average cost rises as the quantity of output increases, the firm is said to have *diseconomies of scale*. If the firm's long-run average cost falls as the quantity of output increases, the firm is said to exhibit *economies of scale*. Economies of scale exist then when the production cost of a product decreases when the number of units produced increases. There is, therefore, an inverse relationship between the per unit cost of the product or service and the amount of production or amount of service provided.

When costs fall indefinitely, without limit, at all output levels, then it is efficient for one firm to produce output for the entire industry. If it is efficient for only one firm to produce the entire industry output, a *natural monopoly* is said to exist. However, as Samuelson points out, a pattern of unlimited decreasing cost may be unrealistic in general for a wide range of industries.⁸ Ultimately, the economies of scale will be exhausted causing the cost curve to level out and eventually turn upward. The existence of scale economies is illustrated graphically in Figure 2.1 using the long-run average cost curve.

⁷ While most Economic texts provide standard definitions of scale economies, for this general discussion of scale economies and the methods available for measuring them, I relied upon definitions and discussions in Paul A. Samuelson, *Economics*, 8th Edition (New York: McGraw-Hill Book Company, 1970); Harvey J. Goldschmid, H. Michael Mann and J. Fred Weston, editors of *Industrial Concentration: The New Learning* (Boston: Little, Brown and Company, 1974); Dennis W. Carlton and Jeffrey M. Perloff, *Modern Industrial Organization* (Glenview IL: Scott, Foresman/Little, Brown Higher Education, 1990); and N. Gregory Mankiw, *Principles of Economics* (Florida: The Dryden Press, 1998).

⁸Paul A. Samuelson, *Economics*, 8th ed. (New York: McGraw-Hill Book Company, 1970), 462.

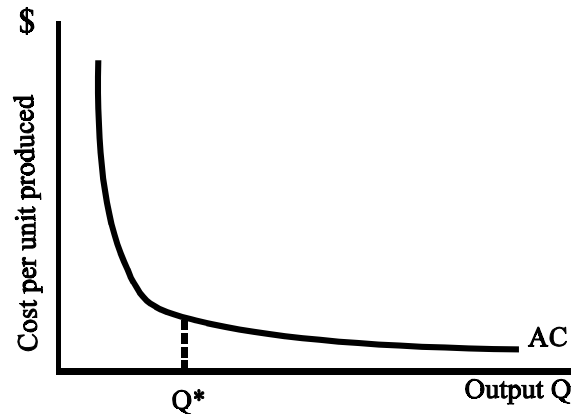
Figure 2.1 Long Run Average Cost Curve



Johnston estimated cost curves for a number of manufacturing firms and found that they tended to be L-shaped.⁹ This means that initially, there are large advantages to size, but eventually those economies diminish and the average costs remain relatively constant. Figure 2.2 graphically depicts a typical L-shaped average cost curve.

⁹John Johnston, *Statistical Cost Analysis*, (New York: McGraw-Hill Book Company, 1960), in Dennis W. Carlton and Jeffrey M. Perloff, *Modern Industrial Organization* (Glenview IL: Scott, Foresman/Little, Brown Higher Education, 1990) 47.

Figure 2.2 L-Shaped Average Cost Curve



2.1.2 Estimating scale economies: There are essentially three methods for empirically estimating the optimal firm size in an industry. They include the statistical cost or production function method, the engineering analysis method, and the survivorship method. All have been used extensively in the economic literature to investigate the relationship between firm size and efficiency, and each have their own advantages and disadvantages.

In a statistical cost or production function study, the actual recorded costs, outputs and other characteristics of firms of varying sizes are compared to empirically examine the production process. Either time series or cross-sectional data are compiled for a wide range of firm sizes, and a production or cost function is constructed to evaluate the production process. Statistical techniques are then used to estimate the relationship between inputs and outputs to determine whether there are constant, increasing or decreasing returns to scale.

While the main advantage of this method is the ability to apply rigorous econometric techniques to the data across a range of firms sizes, the inability to obtain accurate and consistent data is a severe limitation. McGee points out that many of these studies use accounting data that

were prepared for routine business reporting and are unlikely to be relevant in providing insight on the present or future relationship between firm costs and size in a particular industry.¹⁰ He also argues that these accounting-cost or production function studies struggle with asset valuations and a host of other technical difficulties.¹¹

Engineering studies offer an alternative to using accounting records. The engineering approach relies on the expert knowledge of industrial engineers and industry consultants responsible for making decisions that influence plant or firm size. Engineering information and data on technical processes are compiled by developing questions and then surveying firms. The information is then used to analyze how costs vary across a range of firm or plant sizes while holding other cost-affecting variables constant.

As with the statistical cost or production function method, the engineering approach has advantages and disadvantages as well. Since firms tend to periodically compare the costs structures of varying facility sizes, it is possible to collect carefully controlled cost estimates.¹² These estimates can often avoid some of the difficulties associated with accounting data that tend to suffer from differing and arbitrary asset valuation procedures. Weaknesses include the amount of time required to interview sources, problems with small sample sizes, and interviewer-introduced bias.¹³ In addition, as Stigler, McGee and others have pointed out, these studies and the estimates produced, focus mainly on technical processes and information, and are unable to account for important factors such as managerial and entrepreneurial qualities or changes in capacity. As Stigler puts it, “Much of the problem is solved only in the unhappy sense of being

¹⁰ John S. McGee, “Efficiency and Economies of Size,” in *Industrial Concentration: The New Learning*, ed. Harvey J. Goldschmid, H. Michael Mann and J Fred Weston, (Boston: Little, Brown and Company, 1974) 66.

¹¹ Ibid.

¹² Frederick M. Scherer, “Economies of Scale and Industrial Concentration,” in *Industrial Concentration: The New Learning*, ed. Harvey J. Goldschmid, H. Michael Mann and J Fred Weston, (Boston: Little, Brown and Company, 1974) 19.

¹³ Ibid.

delegated to a technologist.”¹⁴

Survivorship studies analyze the changes in various firm-size classes over time for a particular industry. In his influential 1958 paper, George J. Stigler presented the survivorship technique for estimating the optimal firm size or range of firm sizes in an industry. The basic point of the technique is that as firms of various sizes compete with each other in a particular industry, over time, the more efficient firms will survive and prosper while the relatively less efficient firms will eventually disappear. To conduct the analysis, Stigler groups the firms in an industry into size categories based on firm capacity or output, and then observes changes in the portion of industry output generated over time by the different sized firms. If output from a particular size category is declining over time, then it is considered to be a relatively inefficient size. On the other hand, if output from firms in a certain size category is increasing or constant over time, then it is considered to be a relatively efficient size category. Stigler describes the technique:

The survivor technique proceeds to solve the problem of determining the optimum firm size as follows: Classify the firms in an industry by size, and calculate the share of industry output coming from each class over time. If the share of a given class falls, it is relatively inefficient, and in general is more inefficient the more rapidly the share falls.

An efficient size of firm, on this argument, is one that meets any and all problems the entrepreneur actually faces: strained labor relations, rapid innovation, government regulation, unstable foreign markets, and what not. This is of course, the decisive meaning of efficiency from the viewpoint of the enterprise. Of course, social efficiency may be a very different thing: the most efficient firm size may arise from possession of monopoly power, undesirable labor practices, discriminatory legislation, etc. The survivor technique is not directly applicable to the determination of the socially optimum size of enterprise, and we do not enter into this question. The socially optimum firm is fundamentally an ethical concept, and we question neither its importance nor its elusiveness.¹⁵

Stigler’s observation is both simple and powerful: if a particular firm size is efficient then

¹⁴ George J. Stigler, *The Organization of Industry*, Chapter 7 (R.D. Irwin, 1968) 72. Original publication in the *Journal of Law and Economics*, Vol. 1, October 1958.

¹⁵ *Ibid.*, 73.

eventually most firms in the industry will approach that size. He also recognizes that “various firms employ different kinds or quantities of resources,” and as a result “there will tend to develop a frequency distribution of optimum firm sizes,” as opposed to a single optimum firm size.¹⁶

Strengths of the survivorship method include its ability to use readily available data such as U.S. Census data on measures of firm size like capacity or output, and its ability to relate the optimum firm size range to any characteristic which is important for a firm’s survival. According to the survivorship principle, firms that make the correct decisions, including those on firm size, will survive and “be well adapted to their total environment.”¹⁷ In its relation to the two previous methods, Stigler notes that, “The survivor technique avoids both the problems of valuation of resources [caused by the use of firm-generated accounting data] and the hypothetical nature of engineering studies.”¹⁸ The survivorship method has been criticized, however, for having a tendency to produce inconsistent and often erratic results.¹⁹

Care must be taken then, when applying the survivorship method and interpreting results. For example, when using the survivorship method as a means to determine how firm size influences costs, the firms being compared must compete with each other and serve a similar geographic market, e.g., either regional, national, or international. This ensures that firms producing different products or serving different geographic regions, and operating on different product or cost functions, are not lumped together. Such an oversight would result in misleading conclusions on both costs and efficiency. Underlying events and characteristics must also be taken into account when evaluating the data results. To minimize the potential for these errors, Stigler recommends “invoking large numbers of firms so errors tend to cancel or by utilizing

¹⁶ Ibid., 74.

¹⁷ McGee, Note 10, p 94.

¹⁸ Stigler, Note 14, p 73. Emphasis added.

¹⁹ Scherer, Note 12, p 19.

time periods such that errors are revealed and corrected.”²⁰

For two main reasons, Stigler’s survivorship method was selected for this study to measure the extent to which economies of scale exist in liner shipping. First as, Oi and others have noted, extensive data on liner firms are both scarce and in many cases, ill suited for both the engineering and statistical cost or production function methods. Second, since part of this paper’s objective is to expand on previous work that used the survivorship method, the same approach is used in this study.

2.2 Liner Shipping Literature Review

The consensus of recent industry comments is that the liner shipping industry is characterized by advantages to size, both at the plant (vessel) level and firm level, and that the pursuit of these advantages has, in part, motivated carriers to organically increase their size, form strategic carrier alliances, as well as grow through merger/acquisition. The belief that there are economies of scale in liner shipping has been widely expressed by industry participants as well as pundits. For example, a prominent transportation consultant commented that “The 10 largest ocean carriers will increasingly ‘gobble up’ carriers of more medium size because of their ability to take advantage of the industry’s natural economies of scale.”²¹ Moreover, others believe that the consolidation process will continue and that “there are [presently] too many carriers.”²²

Economic studies concerning the ocean liner industry are not numerous and few deal specifically with economies of scale at the firm level. While a number of studies have examined whether there are firm-level advantages to size in liner shipping, they have produced mixed conclusions on the degree to which size advantages exist. Much of this literature is preoccupied with whether *excessive* economies of scale, without limit, exist and give rise to concern over natural monopoly, and therefore, whether there is justification for continuing carrier antitrust immunity. Other studies have investigated scale economies in order to evaluate U.S. government

²⁰ Stigler, Note 14, at 74.

²¹ “Alliances to eclipse conferences in new era” *Journal of Commerce*, October 19, 1998, 1A.

²² “An age of giants,” *Containerisation International*, September 1999, 37.

maritime policies such as those that subsidize U.S. liner firms, each of varying size. If economies of scale existed, without limit, costs could be minimized by a single firm operating the entire U.S.-flag fleet. Such a finding would raise questions about the economic rationale for the present U.S. maritime subsidy program.

2.2.1 Arguments for Antitrust Immunity: Before proceeding with a review of the liner shipping literature that specifically deals with economies of scale, it is useful to provide the general context within which many of these studies were conducted.

As mentioned, the liner shipping industry enjoys immunity from the U.S. antitrust laws and is instead subject to government economic regulation and oversight. The continuation of this antitrust immunity has periodically been reviewed.²³ Historically, a number of rationales have been advanced in support of retaining the industry's antitrust exemption.²⁴ Two are mentioned here. First, it has been argued that substantial economies of scale exist because of the cost structure for liner shipping, i.e., long-run average cost decline over the entire range of output. Because of these purported excessive size advantages, supporters of regulation contend that, without regulation and the conference rate fixing system, the industry would be reduced to very few operators that would collectively possess significant market power.²⁵ One argument for regulation and maintaining the conference system has been that it supports a wider range of liner carriers and therefore, more service options than otherwise would be possible.

A second argument for regulation has been that U.S. liner carriers in particular are unable to compete effectively because of their higher labor and operating costs relative to those of subsidized foreign carriers. The conference system is said to give U.S. carriers sufficient control over shipping rates to ensure their continued survival which serves a national security interest. This rationale, however, could allow less efficient firms (benefitting from direct or indirect

²³Liner carrier antitrust immunity has been Congressionally reviewed and the regulations governing liner carrier concerted activities have been modified several times over the last century, including the 1961 Amendments to the Shipping Act of 1916, implementation of the Shipping Act of 1984, and the 1998 Amendments to the Shipping Act of 1984 (the Ocean Shipping Reform Act of 1998).

²⁴Rationales that follow correspond to those presented in FMC Section 18 Report, *supra* note 2.

²⁵While economies of scale, without limit, would suggest natural monopoly, most industry experts contend that the industry's characteristics cause it to tend towards a more oligopolistic structure.

subsidies) to survive along side more efficient firms.

Many of the economic studies that follow, especially the earlier studies, were undertaken to determine whether *excessive* size advantages existed in liner shipping and whether such unrestricted size advantages, if they existed, gave rise to concern over natural monopoly, and therefore justification for maintaining carriers' antitrust immunity and/or subsidy programs. This focus on excessive economies of scale as it relates to antitrust immunity and government subsidy programs may, however, overlook important technological advancements in the industry, the effect of varying degrees of scale, scope and/or network economies, and the influence these factors can have on a firm's growth strategy.

This paper focuses on whether economies of scale exist in liner shipping and what such economies may mean for industry structure. It is not concerned with antitrust or other policy implications. The studies reviewed cover an extensive time period, during which both the technologies used in the industry, and the federal regulatory environment under which it operated changed dramatically. Therefore, the studies and reports are presented chronologically to highlight differences in their conclusions attributable to these changes.

2.2.2 Pre-Containerization (through the 1950s): One of the earliest studies on the issue of size advantages in liner shipping was done by Walter Y. Oi²⁶ in connection with his work on evaluating the U.S. merchant marine. In order to evaluate a government subsidy program for the U.S. merchant marine fleet which directly effects the number of firms that make-up the U.S.-flag fleet, Oi tested the hypothesis that the maritime industry was characterized by *excessive* economies of scale, i.e., that the unit cost of production (per ton of cargo transported) declined significantly as the size of the firm increased. Oi noted that if larger firms were more economical than smaller firms, costs could be minimized by a single firm operating the entire fleet. If this were the case, U.S. government policies supporting many U.S.-flag firms would need to be re-evaluated.²⁷ Oi's data and analysis covered a period in liner shipping (1917-1958) that preceded

²⁶Walter. Y Oi, "The Optimal Size of Liner Firms" in *The Economic Value of the U.S. Merchant Marine*, by Allen R. Ferguson, et al. (Evanston, IL: Northwestern University Press, 1961).

²⁷At the time, the U.S. subsidy program supported 15 different shipping firms.

the era of containerization.²⁸

Mainly through theoretical discussion, supported where possible by fragmentary evidence, Oi develops an analytic framework for evaluating the effects of the U.S. government's maritime subsidy program and attempts to answer two questions: (1) whether there is a minimum and maximum efficient size for a firm serving a single service; and (2) whether there are upper and lower limits on the efficient size of firms operating over one or more trade routes? Oi's study proceeds by first attempting to establish a lower and upper limit on the efficient size of liner operations in a single market and then evaluates whether a single liner firm, operating over a number of trade routes, can reduce its unit costs by increasing its overall size. The distribution of ships among trade routes operated by 16 U.S. subsidized liner firms for the years 1951 and 1957 are used to test Oi's theoretical considerations on the upper and lower limit on firm sizes for firms operating in a single trade. Administrative costs as a percent of vessel operating costs for six U.S.-subsidized liner firms for 1951 and 1957 are examined to detect advantages associated with managerial and administrative functions of relatively large firms. Fleet sizes (as measured by number of ships) of 215 liner firms operating during 1957 are then examined to evaluate tendencies in firm size and industry concentration level. Finally, data on firm size (as measured by both number of vessels and total vessel capacity) is compiled for 58 British liner companies for six distinct years over the 40-year period 1917-1957, to provide an empirical basis for the judgements previously made about the upper limits on firm size for firms operating over several trades. Here historical changes in the size distribution of the 58 liner firms are evaluated. Oi uses George J. Stigler's, 1958 "survivorship" principle to evaluate the time series data and draw conclusions about the efficient size of a liner firm.

²⁸Until the late 1960s, international liner trades primarily relied on general cargo or break-bulk ships. The concept of using standard-size boxes or containers to transport cargo was introduced in the international trades in 1966 and forever changed the way international cargo was transported. Containers are large metal boxes that can be placed on a tractor-trailer chassis, loaded at the exporter's plant, sealed, shipped by truck or rail to the ocean port, lifted onto a container ship by dockside crane, and stacked in specially designed container slots. At destination, the container itself is unloaded. Containerization has proven to be highly efficient for both carriers and shippers, significantly reducing the time and labor needed to load and unload cargo. Shippers prefer containerization because it means faster delivery and, by reducing handling, minimizes breakage and pilferage.

Oi points out several conclusion that can be drawn from his analysis:²⁹ (1) there are economies of scale which tend to put very small firms at a cost disadvantage relative to larger firms; (2) the most important economies appear to be associated with uncertainty and with the increases in load factors which may be derived from efficiently scheduling ships over several trade routes, but these are not great; (3) these economies are small and diminish as the size of the firm increases; (4) the available data suggest that the minimal efficient firm size is not absolutely large and the data does not support the hypothesis that there are massive economies of scale in the industry; (5) the evidence indicates roughly constant returns over a substantial range of firm sizes meaning that costs per gross ton would be roughly equal for firms with fleets ranging from 10 to 40 ships; and (6) for firms with 3 to 12 ships, costs appear to be roughly constant in serving the average single trade route.

While Oi's work represents a major contribution to the study of liner shipping and specifically an in-depth examination of economies of scale, unfortunately, in the nearly 40 years since it was completed, liner shipping has experienced a revolution brought about by technological and legislative changes that have facilitated significant changes in the types of carrier cooperation and growth strategies being pursued. Oi's conclusions may no longer hold, and his specific conclusions about fleet sizes are no longer accurate. Oi's analysis was also conducted within the context of a highly political debate over the extent to which the U.S.-flag fleet should be subsidized. The focus on the subsidy issue may have tended to obscure Oi's finding that economies of scale were detected, albeit not the sort of *excessive* economies that would suggest the possibility of a natural monopoly.

It is also appropriate to note that many of the studies and reviews that follow, were conducted within the context of a perennial antitrust debate, and often relied on Oi's (by then) outdated findings and emphasis on constant returns to scale. Some proponents of the repeal of antitrust immunity for liner shipping have drawn selectively from Oi's study and emphasized those parts of his analysis and findings that supported their arguments.

2.2.3 Early Containerization (through the 1970s): In examining the price of liner

²⁹Ibid Note 26, p 310.

services and the cost of an efficient service on a particular liner trade route, Devanney, et al., provide some empirical evidence regarding economies of scale in liner shipping.³⁰ The study calculated fleet sizes and costs for different vessel sizes and speeds on a hypothetical U.S./Latin American trade using 1969 export data and 1971 tariff data. The simulation projected that the most efficient system of ships (minimum cost operation) to serve the trade would consist of eight vessels that were considerably larger, slower and fewer than those being used on the actual U.S./Latin American trade route at the time of the study.

While the study's simulation suggested that the most efficient liner fleet consisted of fewer, larger, and slower vessels than those actually deployed by firms currently serving the trade, it did not go as far as to say that costs could only be minimized if only a single firm served the trade. In a footnote, the authors cite and adopt findings from Oi's previous 1960 empirical study which concluded that economies of scale are exhausted beyond roughly three ships deployed on a trade route. However, the data used in the cited study, as well as Devanney, et al., pre-date containerization which implies that this important technological advancement was not a factor in either study.³¹ Moreover, as the authors note, their analysis is restricted to break-bulk cargo handling, “. . . for which no economies of scale exist for any but extremely low-volume trade routes.”³²

Even though the Devanney, et., al., study is regarded as one that casts doubt on whether economies of scale exist in liner shipping, its sole argument is adopted from Oi's outdated 1960 study and buried in a footnote. Moreover, an analysis of break-bulk shipping purporting to provide insight on the economics of (by then containerized) liner shipping, must be viewed with scepticism because the economics of the two types of operations are vastly different. The

³⁰J. W. Devanney III, V. M. Livanos, and R. J. Stewart, “Conference Ratemaking and the West Coast of South America,” *Journal of Transport and Economic Policy*, Vol. 9, No. 2 (May 1975) pp 154-177.

³¹As the Devanney, et. al., study predates containerization, it also predates refrigerated containers, commonly know as “reefers” which have allowed for a reduction in the number of port calls and transit times required for perishable commodities. This innovation has supported a trend toward fewer, larger, yet slower vessels generally, and specifically in trades dominated by perishable goods.

³²Ibid., Note 30, p 156.

Devanney, et. al., study does more to highlight the potential costs of the conference system than it does to shed light on whether there are economies of scale in liner shipping.

During the late 1970s, the debate over carrier antitrust immunity and the need to maintain the current conference system began to heat-up. The next group of studies were prepared in anticipation of legislative changes, and present policy-oriented arguments for and against retaining the industry's antitrust immunity.

Attacking the conference system as it operated in the U.S. trades, the Department of Justice ("DOJ") made the initial presentation. In its evaluation of whether regulated conferences are necessary to prevent single-firm monopoly or destructive competition, the DOJ's 1977 report concludes that the industry is not characterized by natural monopoly and that "[T]here is no evidence that the shipping industry is characterized by economies of scale so large that there is room for only one firm in the trade."³³ The study cites and supports the findings of Devanney et al. (1975).

The Department of Justice's conclusions are drawn from "an examination of the arguments," which are based on previous (and perhaps outdated) analyses, rather than from empirical testing of its own, and support its well know policy position that the liner shipping industry should not enjoy special treatment and immunity from U.S. antitrust laws. The study therefore, offers little in the way of useful new analysis on the issue of economies of scale in liner shipping.

University of Wales Institute of Science and Technology ("UWIST") academics responded critically to the DOJ paper and, among their conclusions, deduced that the industry may in deed be susceptible to natural monopoly.³⁴ The basis for this conclusion rests on theoretical discussion and a reliance on Gilman's (1977) finding that the long-run average cost curve fell continuously throughout its length as the amount of cargo space provided increased,

³³U.S. Department of Justice, *The Regulated Ocean Shipping Industry* (Washington, DC: U.S. Government Printing Office, 1977) 228.

³⁴Department of Maritime Studies, University of Wales Institute of Science and Technology, "Liner Shipping in the U.S. Trades," *Maritime Policy and Management*, Vol. 5, N. 3 (July 1978) pp 141-266.

which reflected technical economies of scale in ship size.³⁵

In evaluating the question of whether price competition is feasible in liner shipping in the absence of antitrust immunity, Scherer examines the arguments and limited empirical evidence offered in the UWIST study regarding natural monopoly.³⁶ One reason that price competition might not be feasible as a market regulator is that the liner industry or particular trade routes may have structural characteristics resulting in natural monopoly. Relying on his extensive background in industrial organization, his study of multi-plant operations and its application to liner shipping, Scherer criticizes much of the UWIST study's logic, conclusions, and lack of comprehensive analysis. Scherer notes that the UWIST study indirectly implies that industry-wide economies of scale exist in liner shipping based on the study's observation that there are substantial economies of scale in *ship size* and that "the practical optimum size of container vessels operating in the North Atlantic is yet to be reached."³⁷ However, Scherer contends that no comprehensive analysis is provided on which to draw such a conclusion. Scherer is more doubtful when considering what appears to be conflicting evidence also offered in the UWIST study.

In 1975, seven carriers serving the U.S./North Europe trade operated 36 vessels making 76 weekly port calls.³⁸ Scherer argues "that if such routes are natural monopolies, it must not be from economies of scale in building and operating individual ships, but from operating multiple ships."³⁹ Scherer's comments are interesting in that he recognizes the possibility of economies of scale in "systems" or "networks" of ships, but goes no further in his paper to explore this

³⁵S. Gilman, et. al., "Containers on the North Atlantic" (Marine Transport Centre, Liverpool University, February 1977, Section s 3 and 5) in Department of Maritime Studies, University of Wales Institute of Science and Technology, "Liner Shipping in the U.S. Trades," *Maritime Policy and Management*, Vol. 5, N. 3 (July 1978) pp 141-266.

³⁶Frederick M. Scherer, "On Maritime Shipping Conferences," *Report of the President and the Attorney General of the National Commission for Review of Antitrust Laws and Procedures*, Vol. II (January 22, 1979) pp 231-247.

³⁷*Ibid.*, Note 34, p 202.

³⁸*Ibid.*, p 163.

³⁹*Ibid.*, Note 36, p. 234.

possibility. Nonetheless, Scherer concludes that further examination of the matter is necessary and that “the evidence currently available certainly does not support an inference that shipping is a natural monopoly.”⁴⁰

Scherer does not offer new data or insight into the question of whether and to what extent size advantages exist in liner shipping, but merely relies on a critical review of a previously conducted study to support his view. He is only able to conclude that, given the current evidence, the question needs more study. Both the previous study and Scherer’s paper were prepared within the context of a policy debate over continuing antitrust immunity for liner shipping. Hence both may have been influenced by political bias on both sides of the question.

Federal Maritime Commission economist, Ellsworth, joined the debate and pointed out that the earlier discussions were incorrectly preoccupied with the question of natural monopoly and instead should be focused on the more relevant question of whether price competition in liner shipping is feasible given the industry’s economic characteristics. In his 1979 paper, Ellsworth evaluates the political and economic factors involved in determining whether unfettered competition is workable in liner shipping.⁴¹ Within this context, Ellsworth discusses whether economies of scale in liner shipping exist. He argues that in the long run “the ocean liner industry does not qualify as a natural monopoly - such as a public utility - because economies of scale are not great enough to lead to a monopoly solution . . . such that one firm could supply the entire market before all economies of scale are exhausted.”⁴² Ellsworth notes that he has only analyzed economies of scale for the production unit and has not analyzed the industry sufficiently to determine whether economies of the managerial, financial or marketing units would lead to a concentrated industry.⁴³

⁴⁰Ibid., p 235.

⁴¹Robert A. Ellsworth, “Competition or Rationalization in the Liner Industry?”, *Journal of Maritime Law and Commerce*, Vol. 10, (1978-79) pp 497-517.

⁴²Ibid., 503.

⁴³In the short-run, however, Ellsworth believes that costs behave such that the liner industry is susceptible to intense price competition otherwise know as “cutthroat” or destructive competition. In liner shipping, he observes that while the capital intensity is not high enough to lead to a natural monopoly
(continued...)

Several additional empirical studies were published in the early 1980s and rely on late 1970s data to support their respective arguments.

Empirical evidence regarding the extent of economies of scale in liner shipping is provided by Frankel, in a 1981 study that attempts to assess the economic impact of various cargo-sharing arrangements between liner operators on the U.S./Far East and Southeast Asia trades.⁴⁴ The study develops a model of actual operating costs for major liner operators, and compares estimated average total and marginal costs for both individual ships and for liner shipping firms' entire fleets or "shipping systems."⁴⁵ While the Frankel study does not attempt to derive long-run costs, short-run cost curves are constructed for average total and marginal costs per TEU of annual capacity deployed. Of specific importance are Frankel's findings related to the system-wide (versus vessel) average total and marginal cost estimates for a number of different-sized liner operators. Short-run curves, at least for the U.S. Pacific/Far East trade, suggest that for the level of service provided by existing competitors of between 200 and 350 thousand TEUs deployed per year, there is very little difference in actual costs between the different size firms.

While Frankel's study is useful for understanding the economic characteristics of liner shipping it is not clear from the analysis what criteria was used for partitioning the data. Two of the three carriers used for the comparison of average costs and size of operations are actually quite close in relative size and therefore it would be expected that their average costs would be

⁴³(...continued)

solution, capital costs and, therefore fixed costs are becoming a larger portion of total costs in the age of containerization. Ellsworth attempts to reconcile his position on short- and long-run costs by arguing that although liner operators do not face decreasing costs in the long run in a technical sense, they do face a continual series of short runs characterized by decreasing costs - since at the start of each voyage they must begin the production cycle again in an initial rate of zero. *Ibid.*, 507.

⁴⁴E. G. Frankel Inc., "Economic Impacts of Cargo Sharing," Volume III, in *Impact of Cargo Sharing on U.S. Liner Trade with Countries in the Far East and South East Asia*, prepared for the Federal Maritime Commission (September 1981).

⁴⁵Data for the period 1979 was used for the study. By 1980, approximately 60% of the world's deep sea general cargo liner trade was containerized (*Containerisation International Yearbook 1981*).

similar.⁴⁶ More interesting, would have been a comparison of cost structures for distinctly different sized firms.⁴⁷

A 1982 doctoral dissertation by a U.S. Department of Transportation Maritime Administration economist, Olin, represents one of the most sophisticated empirical studies of liner shipping.⁴⁸ Olin develops information useful for evaluating the U.S. maritime subsidy program by comparing subsidized and non-subsidized firms to determine if restrictions imposed on subsidized firms could result in different production structures. The study excludes bulk or conventional vessel operations and focuses entirely on the liner industry. It therefore provides the first rigorous, empirical study of the liner industry's production structure. While a number of other studies have been performed at various levels of aggregation, Olin notes that the appropriate unit of analysis in liner shipping is the firm, especially since multi-vessel operation at the firm level influences important characteristics of production. Moreover, "the degree of returns to scale . . . are affected by each firm's fleet size and vessel composition."⁴⁹

Cross sectional data is compiled and econometric methods are used to estimate a translog profit function for a sample of 12 U.S.-flag liner firms over the period 1974-1976.⁵⁰ He uses this function to examine the characteristics of production for liner shipping services and tests for, among other things, the degree of returns to scale. Olin's statistical results do indicate that increasing returns to scale are present at the firm level for liner services. However, he notes that

⁴⁶1980 data compiled for the current study's analysis on relative firm size (as measured by total vessel capacity operated) was used as the basis for this statement.

⁴⁷Frankel obviously made use of the available data - detailed cost data for several U.S.-flag carriers and a few non-U.S. flag operators. While this type of data is usually available on U.S. flag carriers due to government reporting requirements, it is not typically available for most carriers. This may be why the observations are not as rich as one would like.

⁴⁸Gary L. Olin, "The Structure of Production in the United States Liner Shipping Industry," (Unpublished Ph. D. Dissertation, The Catholic University of America, 1982).

⁴⁹Ibid., 22.

⁵⁰According to Olin, a translog profit function is the appropriate functional form to use when estimating the profit function because it allows, among other things, returns to scale to vary with the level of output.

the statistical results indicate that “the extent of increasing returns to scale may not be great.”⁵¹ Olin does not, however, then discount the importance of his findings simply because the results do not confirm *excessive* economies of scale -- suggesting natural monopoly or oligopoly – but rather relates his findings to actual observed behavior in the industry.

Olin notes that in recent years a number of U.S.-flag operators have gone out of business despite U.S. subsidies, and believes that the presence of increasing returns to scale may partly explain this decline. Olin further observes that the maritime subsidy program is flawed because it fails to take into account the size of operations when attempting to assist U.S.-flag operators. Increasing returns to scale imply that the inherent advantage that large scale operators have over smaller operators cannot be overcome by the equalization of factor prices.⁵² Hence, the failure of the program to keep some U.S.-flag operators in business. Olin also observes that foreign-flag operators “already may take advantage of increasing returns to scale through consortia [alliances] that share vessel space on particular trade routes.”⁵³ Because increasing returns to scale at the firm level can allow operators to become more efficient simply by increasing the size of their operations, Olin advocates similar arrangements to be permitted by the remaining U.S.-flag operators.⁵⁴ In addition, more than half of the defunct companies only operated on a single trade route and may have been victims of inefficient size operations. Olin points out that “this lends credence to the argument that single trade-route operators are not as efficient as multiple trade-route operators.”⁵⁵

Olin’s study and conclusions illustrate the importance of looking beyond the absence of a finding of *excessive* economies of scale, and recognizing the significant technological

⁵¹Ibid., Note 48, p 65.

⁵²Ibid., p 69.

⁵³Ibid., p 71.

⁵⁴At the time of Olin’s study, these types of carrier arrangements were not widely used by U.S.-flag operators. Today, various types of carrier operational rationalization arrangements are employed extensively by all carriers such as, space charter, sailing and cooperative working agreements.

⁵⁵Ibid., Note 48, p. 69. Olin later states that increasing returns to scale in the industry may result in part from the ability of firms operating on multiple trade routes to adjust to fluctuations in demand on individual trade routes. p. 70

advancements in the industry, the effect of varying degrees of scale, scope and/or network economies, and the influence these factors can have on a firm's growth strategy. According to Olin, even though *excessive* economies of scale may not be present, size does appear to be important in liner shipping, and may suggest that an industry structure characterized by a smaller number of larger firms would be more efficient.

2.2.4 Mature Containerization (through the 1980s): During the late 1980s and early 1990s, another collection of liner shipping studies were published, again in anticipation of legislative review of, and possible changes to existing shipping statutes. These papers were primarily theoretical rather than empirically based.

Within the context of evaluating various transport pricing theories available for explaining differential pricing in liner shipping, the FMC Section 18 Report⁵⁶ agrees with and adopts the view that the decision making unit, namely the shipping line, and the system of ships and other factor inputs capable of providing a weekly service, is the appropriate unit of production rather than the sailing. If it is accepted that the system is the more appropriate definition of the unit of production, then the possibility arises that there will be scale economies that are yet to be exploited since constraints on service frequency limit the ability of lines to vary their supply and, therefore, their ability to exploit economies in ships' size.⁵⁷ The FMC Section 18 Report further cites other work (Gilman 1983) that showed economies related to ship size on both short-sea and deep-sea routes, and points out that ships larger than twice the size of those evaluated by Gilman had been introduced into the industry by 1989.⁵⁸ This suggested that Gilman's calculations may have underestimated the economies in ship size that were available. The FMC Section 18 Report further states that, "since the economies in ships' size have apparently not yet been exhausted, it seems reasonable to conclude that, in general, lines

⁵⁶Ibid., Note 2, *Section 18 Report on the Shipping Act of 1984* (1989). This study, as well as the forthcoming FTC (1989) study, was Congressionally mandated. Both were comprehensive studies designed to analyze the impact of the Shipping Act of 1984. Data collected by the FMC was used by the FTC in its analyses.

⁵⁷Ibid., p 413.

⁵⁸S. Gilman, R.P. Maggs, and S.C. Ryder, *The Competitive Dynamics of Container Shipping* (Aldershot: Gower Publishing Company, 1983) in FMC Section 18 Report, Note 2, p 413.

operating in deep-sea liner trades are faced with long-run decreasing costs.”⁵⁹

In response to the FMC Section 18 Report, the Federal Trade Commission (“FTC”) reached the conclusion that the liner industry has room for more than an oligopoly number of efficient-sized firms.⁶⁰ For example, using data collected by the FMC for its Section 18 Report, the FTC report found that, as of 1988, there were 30 carriers operating in the U.S. to Far East North Pacific trade, 16 carriers in the U.S. to Singapore and Malaysia trade, 28 carriers in the U.S. South Atlantic to Northern Europe trade, and 25 carriers in the U.S. Atlantic to Italy trade. Within this group of trades, the market share of the four largest firms varied from 39 to 65 percent.⁶¹ If large firms had lower costs, they would be expected to grow by merger or otherwise, until they dominated the market. The FTC report concludes, however, that these figures, combined with evidence that carriers have frequently entered new trades, tend to refute the hypothesis that large firms enjoy cost advantages over smaller firms and that a few firms would dominate the industry under a free market.⁶²

The Report of the Advisory Commission on Conferences in Ocean Shipping (“ACCOS Report”) reviews the empirical literature and historical arguments regarding conferences in liner shipping, and provides some limited empirical evidence on the issue.⁶³ Relying on data⁶⁴ collected for the FMC’s Section 18 Study and subsequently updated, the ACCOS Report observed the size of carriers presently operating in the major U.S./foreign trades and found “that

⁵⁹Ibid., Note 56, p 413.

⁶⁰Report of the Federal Trade Commission, *An Analysis of the Maritime Industry and the Effects of the 1984 Shipping Act* (Washington, DC: U.S. Government Printing Office, November 1989).

⁶¹The FTC statistics were obtained from the FMC Section 18 Report, pp 276, 283, 289, and 294.

⁶²The FTC Report makes no distinction between *de novo* entry and cross-trade entry by carriers already active in other trade routes. However, this is an important distinction when discussing the frequency with which “carriers have entered new trades.” In actual fact, while most existing firms have expanded their operations to now include multiple or cross trades, many other firms have exited the industry and very few new firms have entered over the last two decades.

⁶³Ibid., Note 2, *Report of the Advisory Commission on Conferences in Ocean Shipping* (April 10, 1992).

⁶⁴The ACCOS report relies on the same data as that used by the FTC Report on firm concentration and entry and exit patterns.

the efficient size firm does not have to be especially large relative to demand in the market.”⁶⁵ The ACCOS Report bases this conclusion on the assertion that the ocean liner industry is open, with few barriers to merger or entry into particular trades, and therefore the carriers that are currently operating must have attained the size needed to maintain efficient operations.

The ACCOS Report acknowledges, however, that the characteristics and structure of the industry may be changing. Carriers were already having to provide round-the-world service, build large intermodal networks, establish more cooperative ventures and were, in some cases, merging in order to stay competitive.⁶⁶ Moreover, the ACCOS report concedes that its conclusion that “carriers currently operating must have attained the size needed to maintain efficient operations,” would not necessarily follow if there were substantial barriers to entering individual trades, and where carriers may have to form large networks in order to reach an efficient scale. According to the ACCOS Report, in such a case, the observed size of a carrier will not necessarily indicate the efficient outcome.⁶⁷

The ACCOS Report’s emphasis on the structural changes taking place in the liner shipping industry and the impact these changes are having on the efficient firm size is significant. Where the previous relevant market may have been the individual trade lane, today’s liner operators are now building global networks. Substantial financial and operational barriers do exist in developing these large scale multi-trade networks, and the scope of liner operations has definitely moved from isolated individual trade lanes, to multiple, inter-connected trade routes and global operations.

Two related works suggest that the technology of the industry has caused it to tend towards increased “network economies,” which implies that the vessel and firm size required for efficient operation has increased. Both papers argue that the liner shipping industry has been maturing as a “declining-cost, network business” as opposed to the product-oriented business it had primarily been prior to containerization. This shift in business orientation, the authors

⁶⁵Ibid., Note 63, p 70.

⁶⁶Ibid., p 71.

⁶⁷Ibid., p 85.

separately write, was brought about by both regulatory and technological changes that have altered the traditional economic characteristics of the industry.

In a paper prepared on behalf of the Ocean Common Carrier Coalition for submission to ACCOS, industry consultant Booz-Allen & Hamilton, Inc., asserts that “the liner industry is emerging as a network business” which “are almost universally regulated because their economic characteristics are such that they tend strongly to monopoly and usually provide essential services.”⁶⁸ The study notes that before the introduction of marine containers, the liner industry was a product oriented business, moving goods from port-to-port without intermediate consolidation or transshipment, and remained so for over a decade even after the introduction of containerization. The primary benefits of containerization were limited to reduced pilferage and damage, and increased port productivity. It was not until the development of “minibridge” services in the early 1970s that the liner industry began its transition from a product to a network business. “As the liner carrier’s networks matured, the structural and economic characteristics of the industry began to mirror those characteristics of other network businesses.”⁶⁹ Comparing liner shipping with other regulated network businesses like energy utilities and telecommunications, the report outlines three characteristics of network businesses in general and concludes that liner shipping is characterized by: (1) significant economies of scale, with marginal costs below average costs at relevant levels of output; (2) large investment requirements, and consequent barriers to entry and exit; and (3) the provision of essential services.⁷⁰

The study lacks firsthand empirical evidence on the extent of economies of scale in liner shipping, yet its observations have generally been on track with respect to the continued evolution of the industry in the years since its publication. Capital investments, vertical expansion into related logistics functions, and industry consolidation continue. Barriers to entry have grown significantly while no new major operator has entered the industry and survived.

⁶⁸Booz-Allen & Hamilton, Inc., “The Need for Retention of Common Carriage in Ocean Shipping,” (study prepared for the Ocean Common Carrier Coalition) September 12, 1991, p 1.

⁶⁹Ibid., 11.

⁷⁰Ibid., 7.

The study points out more clearly what a number of other studies have suggested -- that the industry has been in a state of disequilibrium over the last three decades caused by both deregulatory and technological changes, and that these changes have caused the industry's structure and economic characteristics to change -- including the degree to which size advantages exist.

A very similar line of argument is offered in a report by Professor David A. Butz, an independent economist hired by ACCOS.⁷¹ While evaluating the antitrust elements of the Shipping Act of 1984 and the arguments for and against carrier antitrust immunity, Butz challenges one school of thought and a number of econometric studies that suggest that scale economies do not extend beyond the operation of individual ships, and consequently do not give rise to concerns over potential monopoly power.⁷² Critics of the industry's special treatment use this conclusion to argue for removal of carrier antitrust immunity. Butz argues that this focus on excessive economies of scale "overlooks both network externalities and economies of scope."⁷³

Butz explains that network effects exist whenever the unit costs of operating a network fall as the volume of traffic through the network increases. Any action in one area of the system affects the entire network. For example, adding trade routes that attract new cargo to the network would lower overall per unit costs. In 1990, Butz notes that seven carriers operate or plan to operate comprehensive round-the-world networks, and concludes that ". . . carriers that operate extensive networks – including global route structures, intermodal links, and frequent service along individual trades – may have significantly lower unit costs than carriers that do not."⁷⁴ The number of ocean carriers that are now considered "global," "multi-modal" operators has more

⁷¹David A. Butz, "Report to the Advisory Commission on Conferences in Ocean Shipping," December 9, 1991, in *Report of the Advisory Commission on Conferences in Ocean Shipping*, April 10, 1992. Professor Butz was retained to provide the Advisory Commission with an "neutral" review and economic evaluation of the liner industry in general and the conference system in particular.

⁷²Ibid., 12.

⁷³Ibid.

⁷⁴Ibid., 13.

than doubled.⁷⁵

Butz's research also concludes that the more successful ocean carriers tend to integrate into related businesses such as inland transportation services, and that these efforts could be motivated by economies of scope.⁷⁶ The per unit cost of transporting a container on the ocean leg decreases if the liner operator also coordinates or controls the inland transportation of the container. By combining the two services, the liner operator can offer the shipper a transportation "package" that, in theory, would be at a lower per unit cost than had the movements occurred separately. Since the liner operator already controls the logistics information pertaining to the ocean move, it tends to be in somewhat of an advantageous position to also coordinate the inland transportation on either end of the ocean move. Today, with few exceptions, liner operators offer through, intermodal services to shippers in addition to the traditional port-to-port service. And most of the top 20 carriers offer "total logistics packages" including ocean and inland transportation, trucking, rail, warehousing, distribution, etc.

Exploiting network externalities and economies of scale and scope, Butz argues, requires enormous investments in infrastructure, and the development of these large scale operations has significantly raised the barriers to entry in liner shipping. Prior to the regulatory environment created by the Shipping Act of 1984, Butz writes, it may have been very difficult for carriers to exploit these efficiencies. "But in more recent years ocean carriers have stepped up their activities in intermodalism, and their efforts could accelerate in a less regulated environment in the future."⁷⁷ The investments that carriers must make in these networks also makes both entry

⁷⁵Since Butz's paper, the number of global carriers has grown to include nearly all of the top 20 carriers world-wide including: Sea-Land, Evergreen, A.P. Moller Maersk, Hanjin, American President Lines, Hyundai, Orient Overseas Container Line, NYK, Cosco, K Line, Mitsui OSK, Hapag Lloyd, P&O Nedlloyd, Mediterranean Shipping, etc.

⁷⁶Economies of scope exist when a single production process can provide two products at lower per unit costs than if the products were produced separately.

⁷⁷The Ocean Shipping Reform Act of 1998 ("OSRA") is seen by many as deregulatory, while others view the changes as mainly fostering a more competitive environment in which carriers may structure their businesses -- especially with regard to confidential service contracts. The changes are indeed expected to promote increased innovation and competition. Well before enactment of OSRA, in anticipation of these regulatory changes, carriers had already stepped-up their efforts to expand into related logistics operations, form carrier alliances and build one-on-one relationships with shippers.

and exit more difficult than many previous studies have acknowledged.”⁷⁸

Butz discounts previous econometric studies that claim the absence of significant economies of scale in liner shipping because they cover periods prior to important technological and regulatory changes. Three main factors are cited: (1) before the widespread application of technological innovations like containerization and electronic data interchange, scheduling and tracking systems, network externalities and economies of scale and scope may have been much less significant; (2) prior to the Shipping Act of 1984, any material network externalities and scale and scope economies associated with intermodalism were foreclosed because carriers’ antitrust immunity did not extend to inland transportation services; and (3) prior to regulatory changes associated with the Shipping Act of 1984, conferences played a more significant role in subsidizing smaller, less capitalized carriers allowing them to capture network externalities and economies of scale and scope without having to be large or well capitalized themselves.⁷⁹

In a later paper, Butz reiterates his earlier argument that like. . . “other transportation industries, ocean shipping enjoys huge network externalities . . . and that carriers with large networks – including frequent and global sailings, intermodal links; and computer systems to manage logistical problems – can have significant advantages over smaller rivals.”⁸⁰ He also points out that it is important to recognize that any study testing for these efficiencies at the firm level prior to the Shipping Act of 1984, would have missed these gains since conferences rather than individual carriers coordinated them.⁸¹

A relatively recent paper analyzed the growing number of mergers and takeovers in the liner shipping industry and argues that the motivation for this consolidation is due to the

⁷⁸Ibid., Note 71, p 27.

⁷⁹Ibid., p 16.

⁸⁰David A. Butz, “Ocean Shipping Economics – Free Trade and Antitrust Implications,” *Contemporary Policy Issues* (July 1993) 69-80.

⁸¹Ibid., 73.

existence of significant economies of scale and scope.⁸² The study contends that because of the economies of single organizations and the diseconomies of joint venture, the efficiency gains of merger or acquisition are far greater than those gains available through an alliance or joint venture. It identifies and quantifies five areas where economies of scale and scope exist, and finds that a carrier with approximately 1 million units of cargo per year has a 15% advantage over a carrier one third that size.⁸³

Finally, a recently published set of studies present evidence on whether economies of scale exist at the vessel (plant) level.⁸⁴ These papers generally conclude that economies of scale in large ships do exist.

2.3 Literature Review Summary

Regarded as *the* major empirical economic study conducted during, and relying on data from, the pre containerization period, Oi's study found very limited economies of scale in liner shipping. Devanney's analysis, conducted during the early containerization stage, concurred with Oi's findings. However, the data used in both studies pre-dated containerization which implies that this important technological advancement was not a factor in either study. During the 1970's, a number of mainly theoretical papers found that economies of scale existed (moderate at most) but not sufficient to expect natural monopoly, nor significant for the largest ships.

Subsequent to the deregulatory changes enacted under the Shipping Act of 1984, the natural monopoly focus is dropped and the focus of the debate shifts to the importance of

⁸²Karl Ahlander, and Christof Rehling, of Roland Berger & Partners, "Predator or Prey," *Containerisation International* (January 1999) 51-53.

⁸³These include: a 10% advantage in cost of ship systems (larger ships with higher speeds, more round trips, improved schedule integrity and network optimization); a 10% advantage in purchasing fuel, terminal services and equipment; a 15% reduction in container expenses (repositioning, etc.); a 25% reduction in pre and on-carriage expenses (intermodal access and agent commissions); and a 40% reduction in overhead/administration expenses.

⁸⁴See for example: Seok-Min Lim "Economies of container ship size: a new evaluation," *Maritime Policy and Management*, Vol. 21. No. 2, (1994) 149-160; R. G. McLennan, "Bigger vessels: How big is too big?" *Maritime Policy and Management* Vol. 24, No. 2 (1997) 193-211; Soek-Min Lim, "Economies of scale in container shipping," *Maritime Policy and Management* Vol. 25, No. 4 (1998) 361-373; Kevin Cullinane and Mahim Khanna, "Economies of Scale in Large Container Ships," *Journal of Transport Economics and Policy*, Vol. 33, Part 2 (1999) 185-208.

intermodal links, network structure, and vessel size as theoretical indicators of increasing economies of scale under a maturing containerization era. Butz and others argue that it was not until the deregulatory changes under the Shipping Act of 1984 that carriers began to more fully realize the advantages associated with containerization. Butz's theory brings us up to date as far as theoretical arguments, but lacks empirical support.

CHAPTER III
CURRENT DATA AND ANALYSIS OF ECONOMIES OF SCALE
IN LINER SHIPPING INDUSTRY

3.1 Economies of Scale in Liner Shipping

The rules of international container shipping have been changing. The formation of carrier alliances, and the growth of mergers and acquisitions have accelerated over the past several years and are expected to continue to shape container liner shipping in the future. While there may be several reasons for engaging in mergers and acquisitions and for forming strategic alliances, a frequently reported reason behind these structural changes has been to achieve economies of scale and scope at both the firm and plant level. This chapter examines current data and tests whether there are advantages to size in liner shipping - the most commonly cited justification for these structural changes. The analysis is conducted using George Stigler's "survivorship" method for estimating the optimal firm size, over a period of more than 20 years by both relative firm size and vessel (plant) size. The data is then used more extensively to update Walter Oi's 1960 survivorship study of economies of scale in liner shipping. In addition, data on a subset of liner firms is analyzed to more closely examine changes in firm size over time.

3.1.1 The Data

As with previous attempts to study and quantify the economic characteristics of liner shipping, data for this study was not readily available nor was it in a form that could be used directly to test for economies of scale. While Oi used a data set that consisted of 58 British liner firms that, to some degree, continuously served the liner trades during his study's 40-year period, no such current data set existed at the time of this study. Therefore, raw carrier-specific statistics were compiled from various *Containerisation International* ("CI") *Yearbooks* and then aggregated to a level similar to that used by Oi, before any analysis employing Stigler's

survivorship method could be conducted.⁸⁵

Recall, that the basic task of the survivorship method is to compare changes in the size distribution of firms in an industry between two points in time. So in order to perform the analysis, at least two points in time must be selected for comparison. To evaluate historical trends in the size distribution of liner firms for this study, individual carrier statistics were collected for five specific years over a 20 year period (1977- 1997). This represented the most recent period for which data was available, covered a period of regulatory change, and was subsequent to the introduction of containerization - a period over which the industry gradually adjusted to these changes. The specific years 1977 and 1980 were selected to represent two points in time prior to the passage of the landmark deregulatory Shipping Act of 1984, where as the years 1987 and 1990 were chosen to represent two points in time after deregulation. Statistics for 1997 were included to ensure that the most recently available data and carrier activities were considered.

Once the specific time period was established for the study, the next step was to determine the scope of the data to be collected and aggregated. Given the particular characteristics of the raw data to be used, a number of methodological decisions had to be made. The data source (various *CI Yearbooks*) compiles basic statistics for hundreds of ocean carrier services operating in the international trades, including non-liner, feeder and river-barge services. Since this study only concerns the international *liner* shipping industry, an unbiased criteria had to be established for isolating *liner* services to be included in the study, while at the same time maintaining a balance between compiling a manageable data set, and invoking a large enough number of firms so errors tended to cancel. Moreover, the criteria had to be flexible enough to allow for the inclusion of multiple sized firms over the entire 20 year period and, to the extent possible, maintain a degree of consistency in the carriers being tracked from one period to the

⁸⁵*CI Yearbooks* provide details of operators that offer scheduled container services. Of importance for this study are the fleet-specific statistics of liner carriers including the name of each vessel operated by the carrier, the vessel type, vessel capacity and trade route on which the vessel is deployed. Data contained in *CI Yearbooks* 1978, 1981, 1988, 1991, and 1998 were used. Note that the data published in these Yearbooks are lagged by one year, e.g., data for 1997 are contained in Yearbook 1998.

next.⁸⁶ As Stigler notes, in order that survivorship of a given size of firms over time be evidence of comparative efficiency, firms must compete with firms of other sizes and all of the firms must operate in a common market.⁸⁷

To ensure that the data conformed to these guidelines, the scope of liner services to be included in the 20 year study was narrowed to only those services operating in at least one of the three major east/west trades (i.e., U.S./Europe, U.S./Far East, or Europe/Far East) during each of the five test years.⁸⁸ This criteria allowed for the inclusion of multi-size firms, permitted for a reasonable representation of international liner services, and restricted the data and analysis to liner shipping firms.⁸⁹

After the liner carriers were identified for each of the five test years based on the above criteria, the basic fleet-specific data contained in the *CI Yearbooks* (i.e., vessel name, type, capacity and trade route) were collected and aggregated to generate appropriate fleet statistics for each firm.⁹⁰ The following information was compiled for each firm: (1) total number of vessels

⁸⁶While it is not necessary for a survivorship study to track the changes in the size distribution of specific firms over multiple periods, it is necessary to establish and maintain a consistent criteria for selecting the firms and partitioning the data by size of firm (e.g., small, medium, large) for each test period. Effort was made to include as many firms as possible that continuously served the major trades for each of the five test years. However, given changes in firm operations, bankruptcies, mergers and acquisitions, etc., only 15 firms continuously served the major trades over the entire 20 year period. These 15 firms are a subset of all the firms used in the main analysis.

⁸⁷Ibid. Note 14, p 75. For the purposes of this study, the international liner shipping market is the relevant geographic market or “common market.”

⁸⁸While this geographic criteria does not include all international liner trades, the vast majority of all international shipping, in terms of both cargo volume and value, are transported on these three major trade routes, and therefore serve as an appropriate proxy. Liner carriers serving one or more of these trade routes are more than likely to be ranked among the top international liner carriers whether they are small, medium or large.

⁸⁹While the method adopted filtered out almost all non-liner carriers, additional research and verification of liner status was needed for some operators. Where liner status could not be verified, those operators were excluded from the data set.

⁹⁰Statistics on each carrier’s size was not readily available from the *CI Yearbooks*. Therefore, this information had to be compiled, and aggregated on a yearly basis for each carrier, and then incorporated into fleet statistic tables by carrier for each year. This information was then used directly as the basis for the survivorship study. See Appendix A for an example of the information compiled for one firm for each of the 5 test years. Nearly 275 similar compilations were done for other firms included in the data set (See (continued...))

operated, (2) total capacity (measured in TEUs) operated, (3) weighted average vessel (plant) size (measured in TEUs), and (4) total number of trade routes served. Two measures of firm size were calculated and used in each phase of the study: (1) the weighted average vessel (plant) size operated by a single liner firm, and (2) the total registered TEU capacity of the ships in each liner firm's fleet.⁹¹

3.1.2 Phase One: Basic application of Stigler's survivorship method and findings

Using the basic time series data, liner firms were ranked in two separate tables according to: (1) each firm's relative size as measured by total registered TEU capacity of ships operated; and (2) each firm's relative size as measured by the weighted average vessel (plant) operated.⁹² For the table concerning firm size as measured by total registered TEU capacity operated, each firm's respective percentage of industry capacity was calculated. Based on this figure, the data was partitioned into five sections according to company size as a percentage of industry capacity. The size groups were classified as "Very Small" (under .5%), "Small" (.5 to 1%), "Medium" (1 to 2.5%), "Large" (2.5 to 5%), and "Very Large" (over 5%). This process was repeated for each of the five test years, the results of which are tabulated and graphically illustrated in Table 3-1.⁹³ A similar ranking and partitioning process was performed in developing Table 3-2 on the distribution of liner shipping capacity as measured by the weighted average vessel (plant) size operated.

Over the two decades covered by Table 3-1, there has, in general, been a persistent and fairly rapid decline in the share of the industry's capacity in firms with less than 2.5 percent of

⁹⁰(...continued)
Appendix B).

⁹¹Stigler notes that firm size has been measured by capacity in the past since production is not usually reported by individual companies. And, since capacity is expressed in the analysis as a percentage of the industry total, it eliminates the influence of the secular growth of industry and company size. *Ibid.*, Note 14, p 75.

⁹²See Appendices C and D for aggregated fleet statistics and calculations used for the 5 test years.

⁹³The technique of ranking and partitioning the data follows Stigler's examples given in his analysis of the steel ingot and petroleum refining industries. *Ibid.*, Note 14, pp 76-77 and 86-87.

the total. According to the survivorship approach, this implies that this size range of firms is subject to substantial diseconomies of scale. Within this group, the decline in market share is most pronounced in those firms (“Medium”) with 1 to 2.5 percent of the total industry capacity. The market share of “Very Small” and “Small” firms fluctuated during the period, but persistently declined after 1987. Overall, these two size classes exhibited diseconomies of scale. Firms with more than 2.5 percent of industry capacity (“Large” and “Very Large” firms) grew or held their share, constituting the range of optimal firm size. Carriers with more than 5 percent of industry capacity (“Very Large” firms) grew by a significant 62% over the 20 year period.

This pattern of relatively smaller firms’ loss of industry market share and the growth of market share by larger firms is more pronounced when shorter time periods are examined. For example, over a 10 year period from 1987- 1997, “Very Small,” “Small,” and “Medium” size firms lost 35, 76, and 53 percent market share, respectively. Over the same period, “Large,” and “Very Large,” firms gained 1 and 116 percent market share, respectively. In addition, over the same 10-year period, the number of firms operating in at least one of the major east/west trades fell 68 percent from a high in 1987 of 67 carriers to 40 carriers in 1997 - indicating a trend towards consolidation in the industry.⁹⁴

⁹⁴While it is not clear as to what happened to a number of firms from 1987 to 1997, a close examination of the data and historical trade reports shows that the vast majority of firms that no longer provided service in 1997 either filed for bankruptcy (3) or were acquired/merged with other liner firms (15) who continued to serve at least one of the major east/west trades.

Table 3-1: Distribution of Liner Shipping Capacity by Relative Size of Company

| Company Size (Percent of Industry Capacity) | | Percent of Industry Capacity | | | | | Number of Liner Shipping Companies | | | | |
|---|----------|---------------------------------|-------|-------|-------|-------|---------------------------------------|------|------|------|------|
| | | 1977 | 1980 | 1987 | 1990 | 1997 | 1977 | 1980 | 1987 | 1990 | 1997 |
| Very Small | Under .5 | 2.30 | 6.04 | 3.94 | 2.48 | 2.56 | 8 | 19 | 21 | 13 | 10 |
| Small | .5 to 1 | 7.05 | 6.03 | 10.88 | 9.34 | 2.63 | 8 | 7 | 15 | 12 | 4 |
| Medium | 1 to 2.5 | 30.21 | 24.19 | 24.80 | 23.50 | 11.58 | 18 | 17 | 16 | 16 | 8 |
| Large | 2.5 to 5 | 34.74 | 44.69 | 41.07 | 46.60 | 41.47 | 10 | 14 | 12 | 13 | 12 |
| Very Large | over 5 | 25.70 | 19.05 | 19.31 | 18.08 | 41.75 | 4 | 3 | 3 | 3 | 6 |
| Total | | | | | | | 48 | 60 | 67 | 57 | 40 |

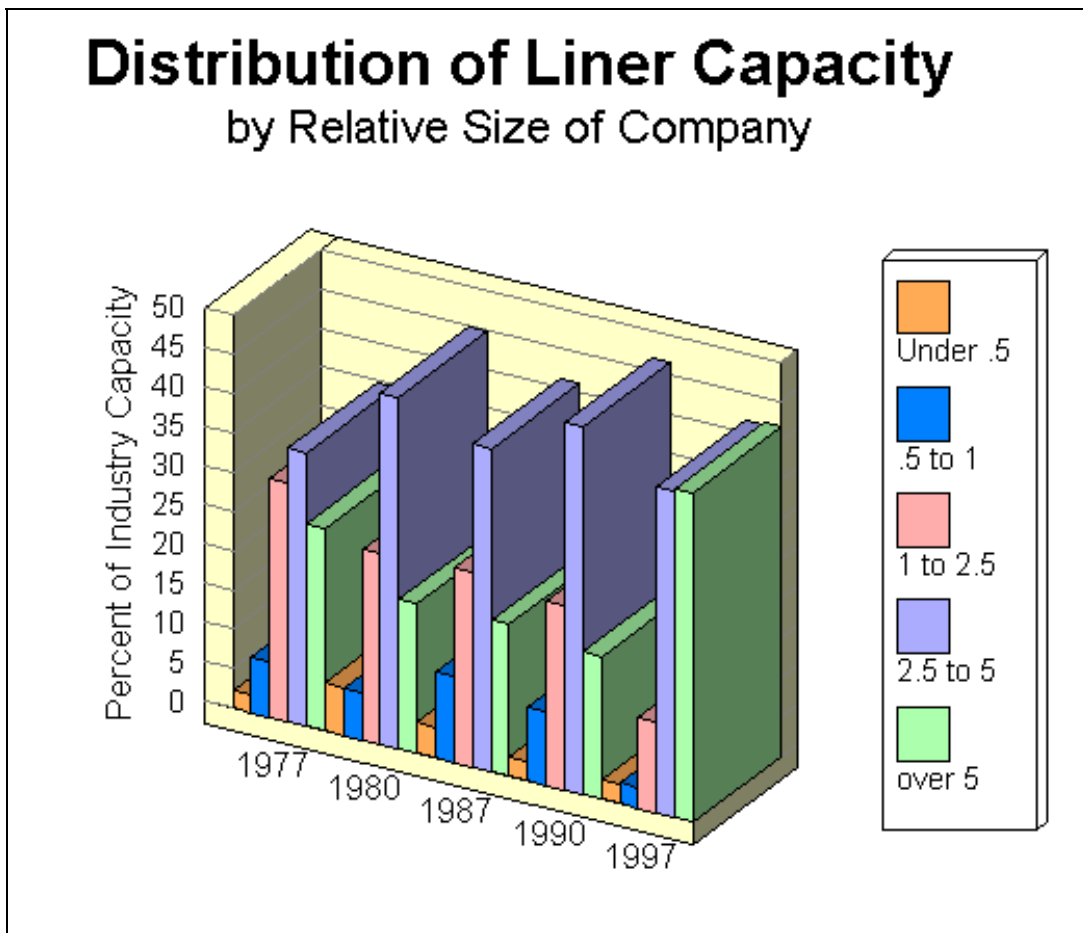


Table 3-2 (on the following page) is an extension of the above analysis and shows the estimated most efficient size of vessels (plants) that operated in the container liner shipping industry during the same period. Each firm's weighted average vessel (plant) size was calculated, and from this figure, each firm's share of industry plant capacity was determined. The data was then partitioned into eight sections according to plant size as a percentage of industry capacity. This process was repeated for each of the five test years.

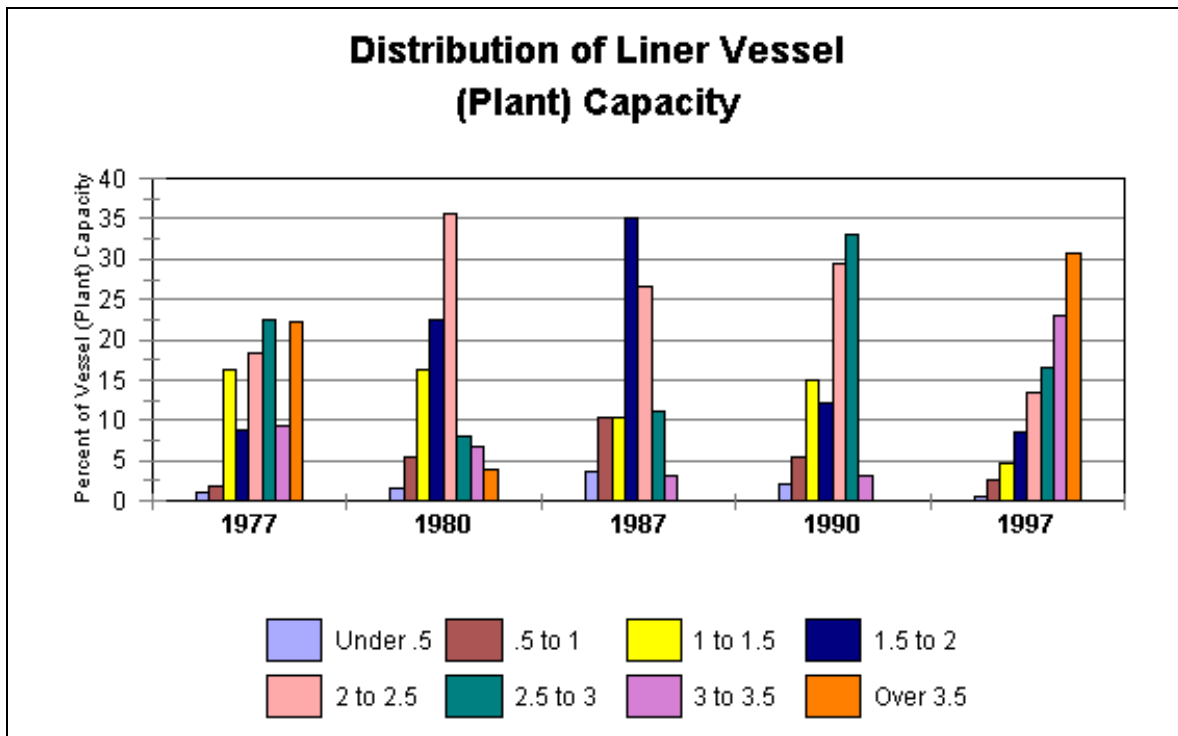
Once again the data reveal that the smallest vessels (plants) have a tendency to decline relative to the overall industry, which is also implied by the previous firm capacity data. Over the 20-year study period, there is no systematic tendency toward decline in the shares held by vessels (plants) equal to or greater than 3 percent of the industry's total vessel capacity. In fact, the market share of this size group showed significant gains over the 20-year period. This pattern is again more pronounced when the data is examined over a shorter period from 1987 to 1997. Vessel (plant) sizes operated between 2.5 to 3 percent, 3 to 3.5 percent, and over 3.5 percent of industry capacity, increased market share by 51%, 634%, and 714%, respectively. Over the same period, vessels (plants) with less than 2.5 percent of industry capacity consistently lost significant market share.

Of additional interest is the fact that over the 20-year period, the number of vessels (plants) operated across all size groups increased 210 percent. This indicates the presence of economies of scope or economies of multi-plant operation. However, the most significant increase in the number of vessels (plants) operated occurred among those vessels (plants) that represented 3 percent or more of the total industry capacity, or the very largest vessels.

According to the survivorship approach, we may therefore conclude that the tendency of very small plants and companies to decline relative to the industry is due to the diseconomies of small firm size and the operation of small vessels (plants) with less than 3 percent of the industry's capacity. Plant sizes greater than 3 percent of industry capacity have grown relative to smaller plants, so the tendency of the larger firms (2.5 percent or more of industry capacity) to increase market share has apparently been due to the economies of multiple plant operation and larger, overall operations.

Table 3-2: Distribution of Liner Shipping Capacity by Relative Size of Vessel (Plant)

| Plant Size (Percent of Industry Total) | Percent of Industry Capacity | | | | | Number of Vessels (Plants) | | | | |
|--|------------------------------|-------|-------|-------|-------|----------------------------|------|-------|-------|-------|
| | 1977 | 1980 | 1987 | 1990 | 1997 | 1977 | 1980 | 1987 | 1990 | 1997 |
| Under .5 | 1.08 | 1.70 | 3.74 | 1.94 | 0.43 | 28 | 46 | 48 | 29 | 9 |
| .5 to 1 | 1.87 | 5.41 | 10.25 | 5.52 | 2.53 | 12 | 94 | 274 | 137 | 34 |
| 1 to 1.5 | 16.24 | 16.29 | 10.32 | 14.93 | 4.68 | 152 | 127 | 249 | 423 | 103 |
| 1.5 to 2 | 8.67 | 22.41 | 35.22 | 12.07 | 8.46 | 69 | 171 | 401 | 159 | 98 |
| 2 to 2.5 | 18.27 | 35.74 | 26.64 | 29.39 | 13.51 | 138 | 294 | 279 | 349 | 215 |
| 2.5 to 3 | 22.44 | 8.07 | 11.00 | 33.12 | 16.62 | 79 | 82 | 121 | 357 | 392 |
| 3 to 3.5 | 9.24 | 6.58 | 3.12 | 3.04 | 22.90 | 31 | 24 | 3 | 32 | 401 |
| Over 3.5 | 22.19 | 3.79 | 0.00 | 0.00 | 30.87 | 47 | 6 | 0 | 0 | 473 |
| Total | | | | | | 556 | 844 | 1,375 | 1,486 | 1,725 |



The finding thus far, especially the findings for the 1987-1997 period, strongly support the Booz-Allen and Butz theory concerning the likely effects of regulatory changes under the Shipping Act of 1984, and the effects of those changes on economies of scale in liner shipping. Both argue that prior to these legislative changes, individual liner operators were not able to fully realize the advantages of containerization or to coordinate their inland transportation services.

3.1.3 Phase Two: Updating Walter Oi's 1960 Study

In this section, the basic time series data covering the period 1977- 1997 is used to update Oi's 1960 study that attempted to measure the extent of economies of scale in liner shipping. Oi's data covered a 40-year period from 1917 to 1957. The approach used here is simply to replicate much of Oi's test using current liner shipping data and report the findings.

For each of the five test years, firms were grouped into three categories according to whether the average size of their ships were large, medium or small. The definition of the size groups for the 5 years studied are contained in Table 3-3. This classification, according to Oi, allows for a correction in the differences in the tonnage capacities due to variations across firms in the average ship size used and loosely classifies firms by kinds of trades, with smaller vessels being used on the shorter trade routes.⁹⁵

Table 3-3: Definition of Size Groups for the 5 Years Studied.

| Year | Weighted Average Ship Size (Gross TEUs) | | |
|------|---|--------|-------|
| | Small | Medium | Large |
| 1977 | 496 | 1,045 | 1,800 |
| 1980 | 535 | 1,093 | 1,637 |
| 1987 | 607 | 1,511 | 2,237 |
| 1990 | 783 | 1,726 | 2,551 |
| 1997 | 1,134 | 2,333 | 3,319 |

⁹⁵Ibid, Note 26, p 303.

The frequency distribution of liner firms, classified by number of ships operated and grouped by average ship size are presented in Table 3-4 on the following page. The average number of vessels (plants) per fleet, classified by average ship size, is presented in the last column of the table. Overall average fleet size, as measured by the number of vessels (plants) has steadily increased over the 20-year period, and nearly doubled from 26 vessels in 1990 to 43 vessel operated on average in 1997. It is also worth noting that there was a large jump in the average fleet size (as measured by the number of ships operated) in the 1990s. In addition, as illustrated by Table 3-5, average fleet size, as measured by gross TEUs deployed, has similarly increased for all firm size classifications over the 20-year period. It is especially pronounced from 1990 to 1997. This means that the average fleet size has been increasing in terms of both the number of, and size of vessels (plants) deployed.

Table 3-4

**Distribution of Liner Shipping Firms by Number of Ships Operated
and Grouped by Average Ship Size
(Selected Years, 1977-1997)**

| Year and Type of Firm | Size of Fleet | | | | | | | | Total | Average Fleet Size |
|--------------------------|---------------|-------|-------|-------|--------|---------|---------|---------------|-------|-----------------------|
| | 1-20 | 21-40 | 41-60 | 61-80 | 81-100 | 101-120 | 121-140 | 141 & Over | | |
| 1997 | | | | | | | | | | |
| Large-Ship Firms | 1 | 5 | 2 | 3 | 2 | 0 | 1 | 0 | 14 | 81.3 |
| Medium-Ship Firms | 5 | 1 | 4 | 0 | 0 | 2 | 0 | 1 | 13 | 35.2 |
| Small-Ship Firms | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 9.9 |
| Total of 40 | 18 | 7 | 6 | 3 | 2 | 2 | 1 | 1 | 40 | 43 |
| 1990 | | | | | | | | | | |
| Large-Ship Firms | 7 | 7 | 2 | 3 | 0 | 0 | 0 | 0 | 19 | 31.2 |
| Medium-Ship Firms | 13 | 3 | 1 | 1 | 0 | 0 | 0 | 1 | 19 | 26.8 |
| Small-Ship Firms | 12 | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 19 | 20.2 |
| Total of 57 | 32 | 14 | 4 | 6 | 0 | 0 | 0 | 1 | 57 | 26 |
| 1987 | | | | | | | | | | |
| Large-Ship Firms | 11 | 8 | 2 | 1 | 0 | 0 | 0 | 0 | 22 | 22 |
| Medium-Ship Firms | 15 | 2 | 4 | 1 | 0 | 0 | 1 | 0 | 23 | 24.7 |
| Small-Ship Firms | 16 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 22 | 14.6 |
| Total of 67 | 42 | 13 | 8 | 3 | 0 | 0 | 1 | 0 | 67 | 21 |
| 1980 | | | | | | | | | | |
| Large-Ship Firms | 13 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 20 | 18 |
| Medium-Ship Firms | 15 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 12.5 |
| Small-Ship Firms | 17 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 11.7 |
| Total of 60 | 45 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 60 | 14 |
| 1977 | | | | | | | | | | |
| Large-Ship Firms | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 9.8 |
| Medium-Ship Firms | 11 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 16 | 15.6 |
| Small-Ship Firms | 15 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 9.4 |
| Total of 48 | 42 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 48 | 12 |

Source: Compiled by author based on *Containerisation International Yearbooks* 1978, 1981, 1988, 1991 and 1998.

Table 3-5: Average Fleet Size Measured by Gross TEUs Operated

| Year | Average Fleet Size (Gross TEUs) | | |
|------|---------------------------------|--------|---------|
| | Small | Medium | Large |
| 1977 | 2,818 | 7,697 | 19,613 |
| 1980 | 2,664 | 9,420 | 27,585 |
| 1987 | 3,268 | 15,178 | 54,148 |
| 1990 | 6,376 | 23,121 | 73,951 |
| 1997 | 10,861 | 58,700 | 169,282 |

In contrast, Oi found that while the average fleet size as measured by the number of ship deployed declined, the average fleet size as measured by gross registered tonnage generally increased from 1917-1957. This suggested that firms were deploying fewer ships but those being deployed were becoming larger.

Two separate summary tables were developed that illustrate changes in the size of liner shipping firms in adjacent periods as measured by the number of ships per fleet (Table 3-6) and as measured by average gross TEUs per fleet (Table 3-7).⁹⁶ For each pair of adjacent periods, liner firms were arranged into three groups depending on whether they experienced decline, growth, or stability in size between adjacent periods.⁹⁷ The number of firms falling into each group is shown in the first column of each table. The average fleet size, classified by direction of change, appears in the last two columns.

To a certain extent, all three firm size groups experienced growth in the average fleet size in terms of gross registered tonnage over the 20-year period. Of those firms that grew in size, “small firm” sizes represented 36 percent, “medium firm” sizes 43 percent and “large firm” sizes

⁹⁶Appendix E contains the actual detailed liner data used to generate these summary tables.

⁹⁷In order to compare changes in firm size for specific firms, only those carriers that operated in adjacent periods were included in this section of the analysis. Between 1997 and 1990, 35 carriers were evaluated, between 1990 and 1987, 51 carriers were evaluated, between 1987 and 1980, 38 carriers were evaluated, and between 1980 and 1977, 38 carriers were evaluated.

21 percent. However, firms which experienced a decline in average fleet size were concentrated in the “small firm” size range (82%). Only 5 “medium firms” (15%) and 1 “large firm” (1%) experienced a reduction in average fleet size in adjacent periods over the 20-years examined.

In general, the average fleet size of “growth firms” was greater than the average fleet size of the “declining firms” in the initial period.⁹⁸ In addition, the terminal average fleet size of “growth firms” exceed the initial average fleet size of the “declining firms” in each of the adjacent periods. Conversely, the terminal average fleet size of the “declining firms” was less than the initial average fleet size for “growth firms.”

If there are economies of scale in liner shipping, we would expect large firms to grow even larger from one period to the next, and smaller firms to either grow in size or disappear. These data support such tendencies. The data reveal a strong tendency for “large” and “medium” sized firms to increase in size over the 20-year period, while small firms tend to decline in size or disappear.

In contrast, Oi’s analysis of similarly partitioned data for the 1917-1957 period, supported the opposite conclusion. Oi found that all firms tended to “gravitate toward some intermediate range of firm sizes.”⁹⁹ Small firms tended to grow while the largest firms tended to decline in size. This, according to Oi, suggested that the industry was characterized by constant returns to scale.

⁹⁸Three exceptions to this generalization occur in 1977-1980 and 1987-1990, in Table III-6, and in 1987-1990, in Table III-7.

⁹⁹Ibid, Note 26, p 308.

Table 3-6

**Changes in the Size of Liner Shipping Firms
(Measured by Number of Ships)**

| | Number of Firms | Average Number of Ships per Fleet | |
|----------------------|-----------------|-----------------------------------|-----------------|
| | | Initial Period | Terminal Period |
| 1977-1980 Experience | | | |
| Decline | 6 | 17.33 | 11.83 |
| Growth | 28 | 12 | 18.64 |
| Stable | 4 | 4.25 | 4.25 |
| All Firms | 38 | 12.03 | 16.05 |
| 1980-1987 Experience | | | |
| Decline | 8 | 16.13 | 11 |
| Growth | 28 | 15.64 | 32.25 |
| Stable | 2 | 6.5 | 6.5 |
| All Firms | 38 | 15.26 | 26.42 |
| 1987-1990 Experience | | | |
| Decline | 14 | 30.64 | 23.86 |
| Growth | 30 | 27.4 | 34.47 |
| Stable | 7 | 7.86 | 7.86 |
| All Firms | 51 | 25.61 | 27.9 |
| 1990-1997 Experience | | | |
| Decline | 5 | 18.8 | 14 |
| Growth | 28 | 29.61 | 48.5 |
| Stable | 2 | 35.5 | 35.5 |
| All Firms | 35 | 28.4 | 42.83 |

Table 3-7

**Changes in the Size of Liner Shipping Firms
(Measured by Gross TEUs)**

| | Number of Firms | Average Number of Ships per Fleet | |
|----------------------|-----------------|-----------------------------------|-----------------|
| | | Initial Period | Terminal Period |
| 1977-1980 Experience | | | |
| Decline | 3 | 9,253 | 5,954 |
| Growth | 35 | 11,313 | 17,921 |
| Stable | 0 | 0 | 0 |
| All Firms | 38 | 11,151 | 16,976 |
| 1980-1987 Experience | | | |
| Decline | 4 | 15,420 | 12,148 |
| Growth | 34 | 16,018 | 35,410 |
| Stable | 0 | 0 | 0 |
| All Firms | 38 | 15,955 | 32,961 |
| 1987-1990 Experience | | | |
| Decline | 8 | 37,142 | 27,400 |
| Growth | 41 | 29,719 | 40,940 |
| Stable | 2 | 1,774 | 1,774 |
| All Firms | 51 | 22,674 | 33,356 |
| 1990-1997 Experience | | | |
| Decline | 5 | 21,688 | 18,603 |
| Growth | 30 | 43,076 | 96,016 |
| Stable | 0 | 0 | 0 |
| All Firms | 35 | 40,021 | 84,957 |

Following Oi's work, another test was constructed in order to concentrate on the growth activity of medium size firms, ie., firms operating medium size ships (plants).¹⁰⁰ Firms were selected based on their relative weighted average vessel (plant) size operated. This group of firms, operating medium size vessels (plants), were then ranked by total capacity operated and next divided into three groups based on their share of the aggregated gross register tonnage (TEUs): the smallest, mid-sized and the largest firms.¹⁰¹ This process was repeated for each of the five test years. For each of the test years, the aggregated gross registered tonnage (TEUs) of the firms in each category was expressed as a percentage of the total aggregated gross registered tonnage of all medium size firms, held by firms in each category. These percentages represent the shares of the total TEU capacity for all medium size firms. For example, the three largest carriers controlled 53.54 percent of the tonnage capacity available to this group in 1997. These statistics are presented in Table 3-8 below.

Table 3-8: Percentage Share of Aggregated Gross Registered Tonnage (TEUs) for Firms Operating Medium Sized Vessels (Selected Years 1977-1997)

| Year | Percent | | | Number of Firms Operating Medium-Sized Vessels | Aggregate Gross Registered Tonnage (TEUs) (for firms operating Medium-Sized Vessels) |
|------|--------------------|---------------------|-------------------|--|--|
| | Smallest Operators | Mid-sized Operators | Largest Operators | | |
| 1977 | 10.66 | 38.70 | 50.65 | 16 | 208,411 |
| 1980 | 7.52 | 41.81 | 50.67 | 20 | 230,125 |
| 1987 | 7.87 | 32.51 | 59.62 | 23 | 598,255 |
| 1990 | 12.27 | 27.71 | 60.02 | 19 | 584,008 |
| 1997 | 7.68 | 38.78 | 53.54 | 13 | 1,145,717 |

¹⁰⁰Appendix F, contains the actual detailed data used to generate the summary table.

¹⁰¹Medium size firms were divided according to the following formula: those firms that controlled 25% of the medium-size firms' capacity were considered "Large"; those firms that controlled 45% of the medium sized firms' capacity were considered "Medium"; and those firms that controlled 30% of the medium sized firms' capacity were considered "Small." This criteria was used consistently for each of the five test years.

Oi argued that, if there are economies of scale in liner shipping, we would expect the largest firms to control an increasingly large share of the total “medium-sized vessel” capacity available. To some extent this is shown by the data. The share of capacity held by the largest firms steadily increased from 1977 through 1990 - a period over which the average vessel size grew modestly. However, the data also show that between 1990 and 1997, the market share of the “largest” firms dropped from 60 to 53 percent, albeit, still greater than “Mid-sized” and “Smallest” firms’ shares. During the same period, “Mid-sized” firms increased their market share by 11 percentage points, while the smallest firms lost nearly 5 percentage points. A closer examination of the underlying data and the shipping environment provides some explanation for the drop in market share of the largest firms operating “medium-sized vessels” in the last interval.

Recall that the objective of this test, following Oi’s example, is to track the changes over the 20-year period in the market share of liner firms operating “medium- sized vessels.” The criteria for a firm to be included in each of the test periods is that it fall into the group of firms that operate “medium-sized vessels” as specified by Table 3-3. The firms tracked are therefore, not necessarily the same firms from one test period to the next.¹⁰² As such, some firms may be moving into or out of the group of carriers that operate “medium-sized vessels” from one period to the next.¹⁰³ In fact, between 1990 and 1997, 2 carriers were reclassified as operating “small-sized vessels;” 2 carriers were acquired by other firms operating “medium-sized vessels” with the acquiring firm remaining in this category; 2 carriers grew on their own and were reclassified as operating “large-sized vessels;” and 3 carriers were acquired by other firms with the now, larger entity being classified as operating “large-sized vessels.” Moreover, the number of operators of

¹⁰²For example, Sea-Land Service operated “medium-sized vessels” in 1977 and 1987, but operated “large-sized vessels” in 1980, 1990 and 1997. What is important for this test, is that all firms operating “medium-sized vessels” be included and that the criteria for selecting such firms remain consistent over the entire study period.

¹⁰³The criteria and approach used here follows that of Oi’s. However, it is not clear from Oi’s study whether the firms tracked are the same firms from one period to the next. Intuitively, it would seem that over the 40 year period, the set of firms operating “Mid-sized” vessels would certainly change as firms adjust to their environment, as is the case with the current data set. Regardless, since we are observing the percentage changes in the capacity controlled by different groups of firms, it should not matter that specific carriers be included throughout the study period. *Ibid.*, Note 26, p 308-309.

“medium-sized vessels” dropped by 46 percent between 1990 and 1997.

These underlying operational factors, along with the summary data, indicate that between 1990 and 1997, “mid-sized operators” appear to have gained market share at the expense of the “smallest operators” of medium sized vessels, while a portion of the “largest operators” of medium sized vessels upgraded their average fleet size and graduated to the “large sized vessels” category. Thus, the pattern change in the last interval appears to reflect a shift from operating “medium-sized vessels” to more carriers operating “large-sized vessels.”

3.1.4 Phase Three: Analysis of 15 firms continuously providing service over 20-year period

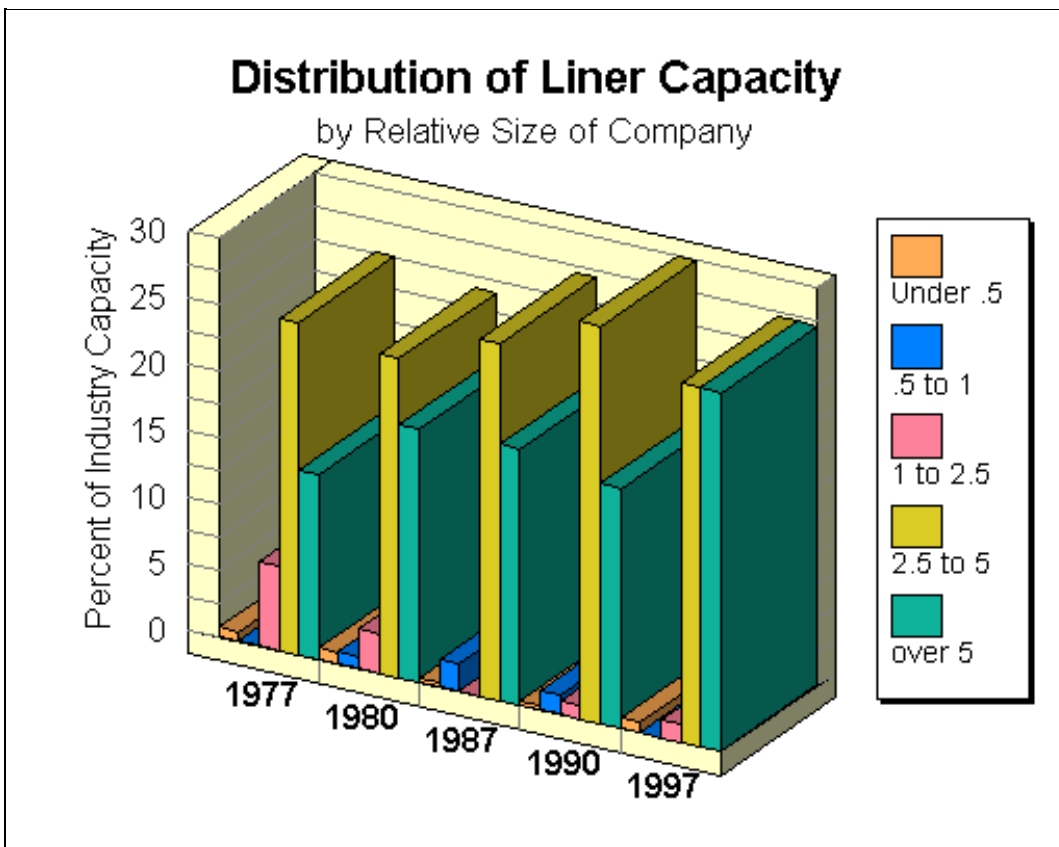
Using the basic time series data, those liner firms that continuously provided services in at least one of the three major east/west trades over the 20-year study period were identified.¹⁰⁴ Total registered TEU capacity of ships operated was used as the measure of firm size. Each firm’s respective percentage of industry capacity was calculated, and based on this figure, the data was divided into five sections according to company size as a percentage of total industry capacity. This procedure was repeated for each of the five test years, the results of which are tabulated and graphically illustrated in Table 3-9 on the following page.

The data patterns shown in Table 3-9 for the subset of 15 firms closely resemble those results found in Table 3-1 which recorded the survivor experience for all firms operating services in at least one of the major east/west trades over the 20-year study period. Once again, in general, firms with less than 2.5 percent of the total industry capacity persistently lost market share over the 20-year period. According to the survivorship approach, this implies that this size range of firms is subject to substantial diseconomies of scale. Within this group, the decline in market share is most pronounced in those firms (“Medium”) with 1 to 2.5 percent of the total industry capacity. The market share of “Very Small” and “Small” firms was declining to flat. Firms with more than 2.5 percent of industry capacity (“Large” and “Very Large” firms) increased market share over the 20-year study period, constituting the range of optimal firm

¹⁰⁴Appendix G contains the fleet statistics for the 15 liner firms for each of the 5 test years.

**Table 3-9: Distribution of Liner Shipping Capacity by Relative Size of Company
(15 Firms that Continuously Provided Service Over 20-Year Study Period)**

| Company Size (Percent of Industry Capacity) | | Percent of Industry Capacity | | | | | Number of Liner Shipping Companies | | | | |
|---|----------|---------------------------------|-------|-------|-------|-------|---------------------------------------|------|------|------|------|
| | | 1977 | 1980 | 1987 | 1990 | 1997 | 1977 | 1980 | 1987 | 1990 | 1997 |
| Very Small | Under .5 | 0.69 | 0.86 | 0.30 | 0.29 | 0.79 | 2 | 2 | 1 | 1 | 2 |
| Small | .5 to 1 | 0.00 | 0.91 | 2.07 | 1.50 | 0.00 | 0 | 1 | 3 | 2 | 0 |
| Medium | 1 to 2.5 | 6.31 | 2.97 | 0.00 | 1.01 | 1.30 | 4 | 2 | 0 | 1 | 1 |
| Large | 2.5 to 5 | 25.06 | 24.04 | 26.96 | 29.96 | 27.05 | 7 | 7 | 8 | 8 | 8 |
| Very Large | over 5 | 13.93 | 19.05 | 19.31 | 18.08 | 27.07 | 2 | 3 | 3 | 3 | 4 |
| Total | | | | | | | 15 | 15 | 15 | 15 | 15 |



sizes.¹⁰⁵ Firms with more than 5 percent of total industry capacity (“Very Large” firms) grew by a significant 94 percent over the 20 year period.

Since the capacity market share for the “Very Small” firm class fluctuated over the study period and was flat overall, the firms comprising this category were examined more closely. Historical trade information and specific operational details for these firms indicate that there may be some room (at least in the near term) for specialized, niche carriers to survive in a growing world of giant, globalized liner operators. For example, Atlantic Container Line operates specialized combination container/roll-on-roll-off vessels capable of transporting both containerized and non-containerized or wheeled cargoes. These vessels are especially well suited for transporting “project” cargoes such as those used for constructing oil drilling facilities, power plants or factories overseas. What makes these operations unique is their ability to accommodate both containerized and wheeled cargoes, e.g., tractors, earthmoving equipment, etc. To the extent that there remains a demand for this type of combination, containerized/roll-on-roll-off service, these types of specialized firms, albeit, only a few, should continue to have a place among the growing number of globalized, multi-trade liner firms.

All three phases of the study show that increasing returns to scale are present in liner shipping. In each application of the survivorship test, small and medium sized firms experienced significant decline in their share of the industry’s capacity, while the largest firms continued to gain market share over the 20-year period. These results provide a plausible explanation as to why liner carriers have pursued various growth strategies including, internal growth, and growth through mergers, acquisitions and alliances. While the finding that economies of scale are present in liner shipping is generally consistent with the more recent studies, this finding differs from the results of a number of earlier studies. There are a number of reasons for these differences.

3.1.5 Explanation of Differences in Study Results

As mentioned in Chapter II, many of the economic studies and reports reviewed,

¹⁰⁵The slight drop in market share for the “Large” firm category from 1990 to 1997, is most likely do to the merger of P&O Containers Ltd. and Nedlloyd Lines - two firms that had been classified as “Large” and subsequent to their merger, fell into the “Very Large” firm category.

especially the earlier literature, were undertaken to determine whether *excessive* size advantages existed in liner shipping and whether such unrestricted size advantages, if they existed, gave rise to concern over natural monopoly, and therefore justification for maintaining carriers' antitrust immunity and/or subsidy programs. The conclusions of studies and reports conducted within the context of a political debate over antitrust immunity or subsidy programs should be cautiously considered. Most of the literature concluding the absence of size advantages, actually do not offer new data or analysis, but merely rely on findings from other previous studies and emphasize those parts that support their policy preferences (regarding subsidies or antitrust immunity). These studies and their arguments are relatively outdated themselves.

Differences between the results of the present study and those of the earlier studies cited may well stem from changes in the technologies used in the industry¹⁰⁶, the prevailing regulatory environment and general trade conditions during each of the study periods. It appears that prior to these factors falling into place, size advantages may not have been as apparent or relevant.

Butz recognizes, that prior to regulatory changes brought about by the Shipping Act of 1984, carriers were prevented from fully realizing the advantages of containerization.¹⁰⁷ By extending antitrust immunity to intermodal ratemaking, the Shipping Act of 1984 permitted carriers to coordinate their inland transportation services and more fully realize the advantages of containerization.

At the same time that container use increased service productivity and reduced per unit costs, advancements in electronic information technologies in liner shipping also helped to reduce transportation costs. The increased power and sophistication of their information systems made it possible for liner firms to closely track cargo movements, reduce documentation costs, and improve customer service while simultaneously improving productivity, accuracy, and

¹⁰⁶Significant technological advancements in ocean transportation including those associated with containerization, intermodal rail services, and electronic data interchange systems, and the production of larger, faster, more cost efficient ships. Cargo handling costs are said to have dropped from \$24 per ton to \$4 per ton, and vessel loading/unloading time accelerated twenty-fold over the previous break-bulk era as a direct result of containerization. The technologies used during the earlier studies were vastly more inefficient compared to those adopted over the past 25 years, and were most likely not conducive to supporting carrier growth.

¹⁰⁷Ibid., Note 71, p 10.

reliability at reduced costs. This became increasingly important as shippers were downsizing their own operations, cutting costs, and increasing reliance on electronic information systems of their own, as well as reliance on carriers' new advanced electronic systems.

Today the largest efficient vessel size deployed in the major liner trades has grown to just over 6,000 TEUs. In the 1970s, the average vessel size was between 1,000 and 1,500. One of the factors driving this increase in vessel size has been the lower per unit costs of operating larger vessels. For example, based on average daily charter rates, the unit cost of operating a 350 TEU vessel costs \$11.29 per TEU/day while it costs \$4.06 per TEU/day to operate a 1,600 TEU vessel.¹⁰⁸ While the per unit cost of operating larger vessels is lower than for smaller vessels, these larger vessels are only cost efficient if they can be filled (or at least filled to a minimum efficient capacity). While one carrier operating alone would likely have difficulty filling this size vessel in today's competitive environment, maximum capacity utilization can more easily be achieved through operational strategic alliances or vessel sharing agreements between multiple operators.

The cost of these giant ships has reached \$100 million and represents a formidable obstacle for even the most well financed firm.¹⁰⁹ To overcome this obstacle, some carriers (even the larger operators) and strategic alliances have jointly financed and/or jointly chartered ships.¹¹⁰ So while the capital costs of chartering/purchasing vessels has become a significant barrier to entry for potential new or *de novo* operators, some existing carriers, often through strategic alliances, have found a way to minimize the individual financial cost and risk of upgrading their vessel fleets and expanding services. Other existing carriers have minimized the cost of fleet upgrades by acquiring or merging with other carriers.

¹⁰⁸Figures based on "Containership Market Report," *Journal of Commerce*, January 1999.

¹⁰⁹In 1995 the cost of building a 6,000 TEU containership reached \$100 million. Ship prices are forecasted to continue to rise because of the increased demand for high quality shipping services. By the early part of the 21st century, new building prices are forecasted to increase 25 percent in real terms over 1995 levels if the current drive for quality continues. "Navigating the High Cost of Fleet Renewal," *Intermodal Shipping*, February 1996, p 10-12.

¹¹⁰Four vessels used by the original "Global Alliance" members were jointly financed by the Alliance members.

3.2 Summary

Application of Stigler's survivorship principle to current data has shown that economies of scale do exist in liner shipping. The data show that the existence of economies of scale at both the firm and plant level is most pronounced during the period 1987-1997, subsequent to significant regulatory changes under the Shipping Act of 1984. Economies of scale in liner shipping have been increasing in response to technology-driven productivity growth, regulatory changes, and higher world-wide trade flows. The pursuit of economies of scale also appears to be contributing (only one reason, but a major one) to the consolidation that is occurring in the liner shipping industry today via both mergers and acquisitions, and the formation of global strategic alliances.¹¹¹ As carriers continue their pursuit of competitive advantages, it is likely that the consolidation currently taking place in the industry will continue.

¹¹¹An examination of capacity shares for the top liner operators also illustrates this trend. The top 20 liner carriers controlled 35 percent of the global capacity in 1986. By 1995 that figure had increased to 46 percent, and this year it is estimated at 53 percent. The trend is more pronounced with the capacity share of the top 10 carriers - 22 percent in 1986 and 38 percent today. *Containerisation International Yearbooks* 1987, 1996 and 1999.

CHAPTER IV
FURTHER CONSIDERATIONS: IMPLICATIONS OF ECONOMIES
OF SCALE ON INDUSTRY STRUCTURE

The previous chapter concluded that economies of scale are present in liner shipping. The present chapter examines the implication of economies of scale on firm and industry structure and examines business strategies presently being pursued. Various alternative business strategies (growth options) are presented and the pluses and minuses of each option are evaluated.

4.1 Liner Shipping Environment Today

Liner operators face challenging times. In today's highly competitive environment, ocean carriers must provide low cost, high quality services to meet more demanding customer needs and respond to expanding world-wide markets. To stay competitive, carriers need to expand services and invest in more efficient (larger and more expensive) vessels and equipment (reefer containers, larger port terminal cranes, etc.). All this must be achieved with limited resources. Return on investment is uncertain, especially in the short-run in light of new tonnage deployments, relatively low operating margins,¹¹² improved quality of non-conference services, low freight rates as most conferences have been unable to mitigate rate reductions, and U.S. and European deregulation.

In response to the challenges faced by carriers today, most would like to simultaneously (1) expand services and acquire more efficient vessels – allowing them to benefit from economies of scope and scale, offer global service and reduce operational costs, (2) minimize financial risks – reduce individual capital investments in vessels, terminals, inland assets, etc., and (3) reduce overall costs – to earn above their cost of capital and to compete successfully with low-cost carriers whose service has improved. For those carriers interested in pursuing these

¹¹²One report showed that the industry operates on net profit margins of 3 percent of total revenue. *American Shipper*, June 1996, p. 48. Another study reported that the average net margins of carriers was under 2 percent. June Lim, "Transamerica Confronting Issue of Mitigating Box-Related Costs," *Shipping Trade News*, July 10, 1996, p 1.

objectives, a number of growth options are available.

4.2 GSAs Defined

For the purposes of this paper, the expression Global Strategic Alliance or “GSA” will be used to describe the cooperative arrangements employed recently by liner operators. Like other horizontal strategic alliances among competitors that have emerged in a host of other industries since the 1980s, GSAs have three primary features:¹¹³

1. Two or more firms unite to *pursue a set of agreed upon goals, but remain independent* subsequent to the formation of their alliance.
2. The alliance partners *share the benefits* of their union and *share control* over the performance of agreed upon tasks.
3. The alliance partners *contribute on a continuing basis* to one or more key strategic areas covered by the alliance.

A GSA is specifically defined as a set of long-term relational contracts,¹¹⁴ between (or among) competitor lines, covering the reciprocal use of each member’s operational assets -- both ocean and land-side -- in the major East/West liner trades (i.e., trades between the U.S./Europe, U.S./Asia, and Europe/Asia). The specific agreement embodied in these relational contracts will change over time as the alliance relationship develops.

From an economic perspective, a GSA can be viewed as a set of long-term, relational contracts, between (or among) competitor lines, covering the reciprocal use of each member’s operational assets -- both ocean and landside -- in the major East/West liner trades. The specific agreements embodied in these relational contracts will change over time as the alliance relationship develops.

For the participant carriers, the major direct benefits of alliance cooperation are: (1) the

¹¹³*Strategic Alliances: An Entrepreneurial Approach to Globalization*, Michael Y. Yoshino and U. Srinivasa Rangan, Harvard University Business School Press, Boston, 1995, p. 2-3.

¹¹⁴Relational contracts, or incomplete contracts, come into play when conditions (for example, uncertainties concerning long-term, alliance-specific investments) make it impossible to write a comprehensive, long-term contract governing all the terms of the alliance. The initial alliance contract will, therefore, have gaps or ambiguities that will be agreed on or clarified by the parties as the relationship progresses.

expansion and improvement of their services, and (2) the limited investment costs and business risk¹¹⁵ that shared participation makes possible. However, alliance cooperation tends to be time consuming and to progress relatively slowly and by incremental stages. It begins with a commitment to general goals at the CEO level,¹¹⁶ and proceeds through additional research and planning to the sequential implementation of a variety of specific cooperative actions.

All ocean liner firms are being driven by the same fundamental forces: the on-going globalization of manufacturing, technological innovations (especially those that support vertical integration of transportation services, and allow economies of scale and scope), and the resulting consolidation of the liner industry. In response to those industry-wide forces, each line assesses its available resources and determines its preferred service approach.

These days carriers have essentially two choices with respect to general service approaches -- either (a) become a *global carrier*, offering a worldwide network, or (b) specialize geographically (and perhaps in terms of function as well) and become a *regional “niche” carrier*.

Once a line has decided whether to be a global service provider or regional specialist, there are essentially three generic competitive strategies available.¹¹⁷ The first two are available to would-be global carriers, the third is the competitive strategy that regional carriers must adopt.

- (1) cost leadership (*i.e.*, offer the lowest price),
- (2) differentiation (*i.e.*, enhance the product/service), and
- (3) focus (*i.e.*, compete in a limited, specialized market).

In today’s international container transportation industry, pursuing any of those competitive strategies requires carriers to invest in expanded and more sophisticated services. A cost leadership strategy requires a carrier to pursue economies of scale and scope, and make

¹¹⁵For further discussion, see Federal Maritime Commission, Bureau of Economics and Agreement Analysis, *Global Strategic Alliances: Where we are Today*, Winter 1996, pp 1-2.

¹¹⁶*Ibid.*, p 6. Such initial agreements, generally codified in a memorandum of understanding, typically include (1) geographic and functional areas of cooperation, (2) the order in which those areas will be addressed, and (3) general principles of the alliance with respect to service levels, gain sharing, etc.

¹¹⁷Michael E. Porter, *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, The Free Press, 1980. See especially Chapter 2, “Generic Competitive Strategies.”

heavy investments in advanced information systems. A differentiation strategy requires that, in addition to economies of scale and scope, a carrier to be able to provide value-added services (transportation and distribution) sought by important shippers. That is, the carrier must be able to offer customized packages of integrated logistics services -- which also requires heavy investment.

Obviously, regional carriers do not establish global alliances. So this paper will not discuss them further, except to note that a regional “focus” strategy requires a carrier to provide a regional network that is extensive enough to compete successfully with both cost-leaders and value-added competitors. The niche carrier must offer a strong specialty service within its trade(s), so that it can compete with the low-priced cost leader by offering superior service -- and, at the same time, compete against the high value, differentiated-service lines by offering lower rates. Consequently a niche carrier’s market is limited to those shippers to whom its geographic trade is important, and who require better than average service, but don’t need a lot of sophisticated logistics services.

4.3. What Growth Option are Available?

GSA’s are only one option for creating a global liner service. Carriers can also expand their businesses by *internal growth* (i.e., by purchasing more assets and hiring more expertise directly in the relevant markets), by establishing *agreement webs* (i.e., a series of separate vessel sharing and/or space charter arrangements in key trade lanes), and by *merger/acquisition* (i.e., by takeover of a competitor’s assets and expertise).

Table 4-1: Summary of Sequential Strategic Choices for Liner Companies

| <i>Service Approach</i> | <i>Competitive Strategy</i> | <i>Growth Option</i> |
|------------------------------|--|---|
| A. Global service | 1. Cost Leader (low price) 2. Differentiate (added value) | (a) Agreement web (b) GSA (c) Merger/acquisition (d) Internal growth |
| B. Regional (niche) services | 3. Focus (niche position) | (a) Agreement web (c) Merger/acquisition (d) Internal growth |

In short, each carrier makes 3 sequential choices. First, whether to offer global service, or defend a particular geographic niche. If the choice is to offer regional service, then the competitive strategy must be to focus on specialized service within that niche. But, if the decision is to offer a worldwide network, then the line must either opt to be the low cost provider of basic ocean transportation (COSCO and Evergreen), or to differentiate its global network from other global operators by offering additional logistics services (a course being pursued by most GSA lines).

Table 4-2 below summarizes the strengths (Pros) and weaknesses (Cons) of the four growth options: (1) *agreement web*, (2) *GSA*, (3) *merger/acquisition*, and (4) *internal growth*. For each of the growth options, seven key factors are evaluated from the perspective of the individual firm contemplating development of a global liner service. These factors include:

- (1) Level of commitment;
- (2) Level of investment/risk;
- (3) Amount of savings;
- (4) Level of flexibility;
- (5) Speed of network/service growth;
- (6) Need for compatible partners; and
- (7) Degree of control over assets.

Table 4-2: Comparison of Growth Options for Would-be Global Carriers

| Growth Options | Pros | Cons |
|--|---|---|
| Agreement Webs (standard contracts) | <ul style="list-style-type: none"> • Minimal commitment • Minimal investment/risk • Initial savings come quickly • Minimal integration (∴ moderate flexibility to change course) | <ul style="list-style-type: none"> • Least scope for total possible savings (only vessel operations) • Slower network growth (∴ Slower service growth) • Need compatible partners |
| GSA (Reciprocal, long-term incomplete contracts) | <ul style="list-style-type: none"> • Increasing commitment • Limited investment/risk (only a portion of total) • Initial savings come quickly • Total possible savings: moderate • Fast network growth (∴ faster service growth) | <ul style="list-style-type: none"> • Shared control of assets • Most savings (terminal & inland) come slowly • Increased integration decreases flexibility to change course • Need compatible partners |
| Merger/Acquisition | <ul style="list-style-type: none"> • Full control of assets • Total savings come relatively quickly • Total possible savings: potentially large (through rationalization of personnel & administrative functions) • Fast network growth (∴ faster service growth) • If successful, highly flexible to change | <ul style="list-style-type: none"> • High level of commitment • High level of risk • High level of investment • Need compatible firm |
| Internal Growth | <ul style="list-style-type: none"> • Full control of assets • Commitment/investment in stages which mitigates immediate risk • No need for "compatible" partner(s) • Highly flexible to change | <ul style="list-style-type: none"> • Slower growth (∴ Slower service growth) • High level of investment |

The table isolates differences in the key factors across the four basic growth options, it also highlights similarities. For example, both *agreement webs* and *GSA*s permit fast initial savings while *GSA*s and *mergers/acquisitions* allow for relatively fast network and service growth.

4.3.1 Agreement Webs: Webs are developed by assembling a collection of trade-specific vessel-sharing and/or space chartering arrangements with a number of competitors. Partners may vary from one trade lane to the next depending on the specific gaps that need to be filled in the carrier's existing services and the availability of compatible partners.

Creating a global liner service through an *agreement web* requires a relatively minimal amount of resources and investment, and therefore exposes the participant lines to lower risk. Once the series of operational agreements have been established, initial operational savings are achieved relatively quickly. Since the strategy involves only vessel operations, integration with partners is minimal – leaving the carrier with greater flexibility to change course if and when customers' demands and/or trade conditions change. However, this growth option provides the least scope for total possible savings since only vessel operations are covered. In addition, as the execution of separate, standard contracts for each section of the global service is relatively time intensive, establishing the entire global network occurs more slowly. K-Line's approach to establishing a competitive global liner service by negotiating a series of slot charters with Yangming and COSCO in the major trade lanes, is an example of an *agreement web* growth strategy.

4.3.2 GSA: Alliances are a set of long-term relational contracts between or among a core set of competitor lines covering the reciprocal use of each member's operational assets (both ocean and inland) and expertise across the major East/West liner trades. They differ structurally from *agreement webs* in that the same set of core competitor lines cooperate across all major East/West trades and the extent of shared operations is greater (*i.e.*, alliances include terminals and inland facilities).

Because the collective resources of a GSA can be deployed across multiple trade lanes simultaneously, GSA's tend to result in relatively fast network development and service growth. However, sharing control/coordination of assets generates transaction costs (the cost of

negotiating, consensus building, alliance oversight, *etc.*). Given the highly complex and extensive relationships required, identifying and securing compatible partner(s) can be critical to maximizing an alliance's expected benefits, and minimizing its potential transaction costs.

GSA's require a higher level of resource commitment than *agreement webs*, yet still leave the individual member exposed to only a portion of the risk. Since GSA's seek to integrate each partners' operational functions (including vessels, terminals and inland facilities) total possible savings are higher than savings from *agreement webs*. The initial savings (from vessel operations) can be achieved relatively quickly, and the majority of savings (from combined terminal and inland operations) is gained more slowly as carriers proceed into each successive operational area. Arguably, member lines forego a certain degree of flexibility with this strategy due to the depth and scope of asset integration.

4.3.3 Merger/acquisition: Mergers and acquisitions involve the takeover of a competitor's assets and expertise in order to create a new, larger entity. If a merger/acquisition has a chance of being successful, highly compatible firms must be joined in order to benefit from potential synergies and elimination of redundant operations and/or functions. Thus total possible savings are potentially high -- through the consolidation of marketing and administrative functions. In addition, total (vs. initial) savings are realized relatively quickly. Properly matched (compatible) firms with complementary services lead to fast network and service growth. Finally, since the newly expanded entity has full control over assets, operations and decision-making, it will be highly flexible to changes in the marketplace.

However, mergers/acquisitions require a high level of commitment and investment, and result in a relatively high amount of exposure to risk. These potential drawbacks are discussed below in the section dealing with the relationship between mergers/acquisitions and GSA's.

4.3.4 Internal growth: Internal growth involves the purchase of more assets and the hiring of more expertise directly from relevant markets. While this approach requires a relatively high level of overall commitment/investment, expenditures can be made in stages, thus mitigating the immediate risk of the overall commitment/investment. There is no need to identify and cooperate with compatible partners -- so, full control of assets is maintained, and the ability to respond quickly to market changes and customer demands is preserved.

So far only two lines, namely Evergreen and COSCO, appear to have the resources necessary to support a competitive global service on a solo basis. And both of those carriers use supplementary slot charters on a limited basis as they primarily pursue internal growth strategies. COSCO, as a state-owned carrier, has enjoyed financial support from the Chinese government -- permitting it to expand on a global basis with limited need to cooperate with other lines.

4.3.5 *Mixing Growth Options:* It is important to note that lines are not limited to the exclusive pursuit of only one growth strategy. Various options can be -- and frequently are -- combined. For example, both COSCO and Evergreen are primarily pursuing strategies of internal growth. But they also share vessels with other lines (*e.g.*, the COSCO, Yangming, K-Line vessel sharing agreements in the transpacific, transatlantic, and Asia/Europe trades). NOL purchased APL and created a new, much larger APL by merging the assets and expertise of the two original lines. Nevertheless, the new APL has continued to actively pursue a global alliance strategy.

The four growth options can also blend one into another. For example, an agreement web can develop into an alliance, as was the case initially with Sea-Land and Maersk. Or an alliance can lead to a merger of the partners. Hanjin, for example, acquired 75 percent ownership of one of its two alliance partners, DSR/Senator; and Maersk, one of the two partners in the Sea-Land/Maersk Alliance, recently announced its acquisition of Sea-Land Service's international shipping assets. Mergers can also provide the basis for new alliances, as evidenced by NOL's purchase of APL -- leading to the creation of the three member (APL, MOL, Hyundai) New World Alliance.

4.4 What's the relationship between GSAs and mergers/acquisitions so far? Are mergers replacing alliances?

Contemporary evidence suggests that recent liner mergers (1) were undertaken primarily when shareholder pressure for improved returns forced a line's management to merge or sell; and (2) have been limited to acquisition of American (APL, Lykes and Sea-Land) and European

(DSR/Senator) lines. So far no major Asian lines have merged or been acquired.¹¹⁸

4.4.1 Merger/acquisition is a high risk/high gain option: Mergers and acquisitions offer the possibility of greater savings than alliances offer; and those savings can be arrived at sooner, because there is no need for a drawn-out process of mutual accommodation of alliance partners.

However, merger/acquisition is usually a riskier strategy than alliance formation. If a merger does not result in the expected benefits or cost savings, the resulting firm may turn out to be a large, inefficient, white elephant. There is also the burden of any additional debt that was contracted to finance the merger/purchase. And a merger is more potentially threatening to the management of the companies involved, since one of the first sources of available savings comes from the rationalization of management personnel. Such risks, may make the merger/acquisition option less attractive to management, even if expected savings would be larger and come sooner than via an alliance.

4.4.2 Alliance formation is a low-to-moderate risk/moderate-slow gain option: When joining an alliance, member lines are choosing a less risky, and less costly option than merger or acquisition. They remain relatively smaller and more flexible companies than would result from a merger -- so, if the alliance doesn't work out, the members aren't burdened by a huge operation, huge asset costs, *etc.*

4.4.3 Mergers do not appear to be replacing GSAs: At least so far, with two exceptions, ocean carrier mergers have not been pursued as an alternative to alliances.¹¹⁹ For example, NOL's purchase of APL was not a shift from a growth-through-alliance option to a growth-

¹¹⁸ It is an interesting point, and one of perhaps no little significance, that the recent run of buyouts has included three US lines acquired by an Asian, a Canadian, and a Danish company (APL by NOL, Lykes by CP Ships, and Sea-Land by Maersk), and a distressed European line acquired by an Asian company (DSR/Senator by Hanjin), and two European companies merging their liner units (to create P&O Nedlloyd); but no major Asian lines were acquired by anyone. What experience we have of Asian lines consolidating, for example the consolidation from 6 Japanese lines to 3 in the 1980s, has been limited to consolidation within one country. That could be because many Asian lines are members of integrated industrial conglomerates (Korea and Japan), or have government involvement (Taiwan, Singapore, China). But whatever the reason, it suggests that any Asian mergers or acquisitions are likely to remain strictly national (e.g., Hanjin acquiring Cho Yang, or NYK absorbing K-Line).

¹¹⁹Hanjin's purchase of 75 percent of DSR/Senator, one of its two partners in the Hanjin/DSR-Senator/ChoYang alliance, and the recent acquisition of Sea-Land's international shipping assets by Maersk are possible exceptions to the "mergers are not replacing GSAs" argument. Both are evidence that at least two of today's GSAs have been, and may become slow-motion mergers.

through-merger option. Nor was the decision of P&O and Nedlloyd to merge their liner operations such a shift away from alliances. The new APL and P&O Nedlloyd have both elected to maintain membership in a GSA. In addition, while CP Ships has designed a patchwork network with its multiple acquisitions, it continues to participate in operational arrangements with other carriers. Indeed, it would appear that mergers/acquisitions have been used to increase the size and market strength of the members of alliances -- almost as if the lines had decided that an alliance of a few very large carriers is the preferred form for GSAs.

4.5 What primary growth options are the major carriers choosing?

The November 1999 issue of *Containerisation International* lists the following lines as the top 10 carriers worldwide (by vessel capacity):¹²⁰

- | | |
|---------------------------|--|
| 1. Maersk-SeaLand | global solo carrier |
| 2. Evergreen | global solo carrier |
| 3. P&O Nedlloyd | global strategic alliance member |
| 4. Med. Shipping | collection of niches (mainly out of Europe) ¹²¹ |
| 5. Hanjin | global strategic alliance member |
| 6. APL | global strategic alliance member |
| 7. COSCO | global solo, w/web covering major trades ¹²² |
| 8. NYK | global strategic alliance member |
| 9. MOL | global strategic alliance member |
| 10. Zim Israel Navigation | collection of niches (mainly out of Europe) |

In the same article, an analysis of which lines have orders for new vessels (including

¹²⁰John Fossey, "Top cat" *Containerisation International*, November 1999, pp 40-43.

¹²¹Mediterranean Shipping is based in Europe and seems to be specializing in niche operations to and from the Mediterranean, Middle East, Africa, Australia, and South America trades.

¹²²It is interesting to note that in the October 1996 issue of *American Shipper*, analyst Philip Damas treated the K-Line/COSCO/Yangming service in the Asia/Europe trade as part of a "consortia web," while in the March 1998 issue he treats the K-Line/COSCO/Yangming trio (now with linked operations in all three major East-West trades) as a new (fifth) global strategic alliance. By that analysis, the number of GSAs has actually *increased* during the recent wave of mergers and acquisitions.

vessels in the range of 5,000 to 6,788) for delivery in 1999 through 2001, a similar list appears:

| | | |
|-------------------|--|--------------|
| 1. Maersk SeaLand | global solo | 128,340 TEUs |
| 2. P&O Nedlloyd | global strategic alliance member | 83,952 TEUs |
| 3. Evergreen | global solo | 65,450 TEUs |
| 4. COSCO | global solo, w/web cover key trades | 57,550 TEUs |
| 5. Hanjin | global strategic alliance member | 40,600 TEUs |
| 6. Hapag Lloyd | global strategic alliance member | 33,600 TEUs |
| 7. OOCL | global strategic alliance member | 33,000 TEUs |
| 8. Yangming | global solo, w/web covering key trades | 27,500 TEUs |
| 9. MOL | global strategic alliance member | 16,500 TEUs |
| 10. APL | global strategic alliance member | 15,160 TEUs |

As a review of these two lists demonstrates, GSAs are far from being a passing fad. Not only are today's largest carriers predominantly members of global alliances, but they are also the carriers investing in new tonnage and especially new super-post-panamax vessels. It would appear, therefore, that GSA carriers likely will dominate the liner industry for the foreseeable future. However, consolidation by merger/acquisition within the industry will likely continue as well, with the larger firms continuing to make use of GSAs.

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APPENDIX A
Example of Fleet Statistics Compiled for Container Service Operators
(1977, 1980, 1987, 1990 and 1997)

(PDF, 14KB, APPEND_A.pdf)

APPENDIX B
Liner Operators Serving at Least one of the Major East/West Trades
(U.S./N. Europe; U.S./Far East; N. Europe/Far East)

(PDF, 8KB, APPEND_B.pdf)

APPENDIX C
Aggregated Fleet Statistics for Container Service Operators
Ranked by Each Firm's Relative Size as Measured by Total Registered TEU Capacity
(1977, 1980, 1987, 1990 and 1997)

(PDF, 26KB, APPEND_C.pdf)

APPENDIX D
Aggregated Fleet Statistics for Container Service Operators
Ranked by Each Firm's Relative Size as Measured by the Weighted Average Vessel Operated
(1977, 1980, 1987, 1990 and 1997)

(PDF, 32KB, APPEND_D.pdf)

APPENDIX E
Changes in the Size of Liner Shipping Firms in Adjacent Periods
as Measured by the Number of Ships per Fleet and
as Measured by Average Gross TEUs per Fleet

(PDF, 39KB, APPEND_E.pdf)

APPENDIX F
Fleet Statistics for Mid-Sized Container Service Operators
(1977, 1980, 1987, 1990 and 1997)

(PDF, 14KB, APPEND_F.pdf)

APPENDIX G
Fleet Statistics for 15 Firms that Continuously Provided Service
Over 20-Year Study Period
(1977, 1980, 1987, 1990 and 1997)
(PDF, 16KB, APPEND_G.pdf)

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