Maritime Economics & Logistics, 2003, 5, (100–115)

www.palgrave-journals.com/mel

Excess Capacity and Entry Deterrence: The Case of Ocean Liner Shipping Markets

MIKE FUSILLO[1]

[1] Director, PIERS Maritime Research Servicer 33 Washington St. Newark, NJ 07102, And Adjunct Assistant Prof. New York University
E-mail: MFusillo@joc.com, MFusillo@aol.com

This paper attempts to shed light on the proposal that firms in concentrated industries may keep excess capacity to forestall entry or expansion by rivals. Excess capacity can deter entry by forming expectations on the part of potential entrants that dominant firms are capable of responding aggressively to threats. But in order to make a convincing case for excess capacity as a strategic entry deterrent, all potential sources of excess capacity must be considered simultaneously. These may include industry-specific structural factors, such as the divisibility of demand relative to supply, economies of scale or wide swings in demand. Ocean liner shipping exhibits structural factors that have led excess capacity for much of its history. It is a concentrated industry that until the late 1990s was dominated by price fixing industry groups known as liner shipping conferences. In spite of limited antitrust immunity granted by most governments to liner shipping conferences, excess capacity is and has been a persistent problem that could be a major cause of operational inefficiencies. As such, ocean liner shipping presents an ideal forum in which to distinguish between excess capacity that is an artefact of structural conditions of supply and demand and excess capacity that may be deployed as a strategic defense against opportunistic rivals. The results of a random effects model with instrumental variables show some limited support for the entry deterrence element of excess capacity in liner shipping.
Maritime Economics & Logistics (2003) **5,** 100–115.
doi:10.1057/palgrave.mel.9100074

Keywords: Excess capacity; entry deterrence; strategic behaviour; barriers to entry; theory of the core; instrumental variables.

INTRODUCTION

The notion that firms would commit resources to costly idle capacity in order to thwart potential entrants rather than adopt a strategy of accommodation appears to be inconsistent with the assumption of rational behaviour and profit maximisation. But empirical work in this topic is relatively rare. What studies do exist tends to favour the doubters. Most of these works, however, suffer from inadequate data rather than shortcomings in the theoretical construct. In particular, there are considerable empirical demands of distinguishing excess capacity from that which may be deployed deliberately to deter entry. Excess capacity is an important issue in liner shipping because capacity costs (stowage factor) are a principal determinant of liner shipping freight rates (Jansson and Shneerson, 1986). Excess industry capacity will thus restrict carriers' ability to maintain sufficient revenues to cover the high fixed costs that prevail in this industry. This paper develops a model of strategic excess capacity in the ocean liner shipping industry; then uses industry data on capacity to test the entry-deterring hypothesis.

Structural sources of excess capacity in liner shipping

Natural monopoly

Significant and chronic levels of excess capacity are typical of industries that exhibit structural features of natural monopoly. Farrar (in Sharkey, 1982) provides a neat summary of these features:

(1) The industry must supply an essential product or service;
(2) The industry must occupy a favourable location for production;
(3) The outputs of the industry must be non-storable;
(4) Production must be characterised by economies of scale; and
(5) The customers of the industry must require a 'certain and a well-defined harmonious arrangement which can only be attained by a single supplier.'

In the strictly qualitative sense, liner shipping roughly conforms to the first four of the above conditions. First, it has been an essential and instrumental component of the dramatic increase in international merchandise trade during the past 50 years; second, it can occur only in seaports with specialised facilities to handle loading and unloading of containers; third, its output is non-storable since revenue losses from empty slots aboard containerships are not recoverable; and fourth, its operations at least at the voyage level can be characterised by economies of scale. Sharkey (1982) added technical conditions to the definition of natural monopoly based on the industry cost function. He concluded that a natural monopoly could exist if the industry cost function is sub-additive, that is, if it is more cost effective for one firm to produce output than for more than one firm. When more than one firm operates non-cooperatively under conditions of sub-additivity, there is likely to evolve a dynamic capacity expansion problem and subsequently, excess capacity.

The dynamic capacity expansion problem in liner shipping can be explained as follows. When faced with linear demand growth over time, and fixed costs to install new capacity, it is optimal for firms to add capacity in discreet units at equally spaced intervals (Sharkey, 1982). This incremental approach permits the supplier to more evenly match capacity with demand growth while economising on the fixed costs of installation. When there are two or more non-collusive firms, each will choose its capacity expansion path independently of the other(s). In spite of the efforts of global alliances in liner shipping, this could lead to prolonged bouts of excess industry capacity because capacity can only be added in large (relative to demand increments) and discreet sizes. Each carrier adds q units of capacity at specific intervals. However, demand growth may support just q/n units of capacity, where n is the number of firms in the market. If the unit costs of adding capacity are non-linear, then each firm choosing independently will attempt to economise on those costs by adding more capacity at less frequent intervals. This makes matters worse since fluctuating demand causes uncertainty in the decision to add capacity. If the cost of supply shortages is higher than the cost of carrying excess capacity, the carrier is more likely to err on the side of excess capacity rather than be caught short during periods of high demand.

By sharing resources or merging, the problem of dynamic capacity expansion in industries that require lumpy supply-side investments eases. Rather than each firm adding q units of capacity when demand for each firm is higher by $q/2$ a collusive agreement may offer each firm's unused excess capacity to meet the growth in demand. In liner shipping, this reasoning is behind the rise of vessel sharing arrangements and carrier alliances during the past decade.

The theory of the core

Rejuvenated by Telser and Bittlingmayer in the 1980s (Telser, 1987, 1991, 1996; Bittlingmayer, 1982, 1985), the theory of the core suggests that cooperative arrangements among firms are less an attempt to impose monopoly prices than they are a response to inefficiencies caused by core emptiness. Core emptiness, defined as an inability to match supply with demand at every point in time, can bring about periods of excess capacity because it fosters instability in market share among dominant firms. Pirrong (1992) and Sjostrom (1989) have both tested the empty core model in ocean shipping markets. In both papers, the notion that liner conferences operate as rent-earning cartels is dismissed. Rather, cooperative arrangements in liner shipping serve to counteract core emptiness that would otherwise cause volatility in market shares and freight rates. Core emptiness in liner shipping is likely a function of its fixed sailing schedules and lumpy capital. Firms engaged in liner trades cannot delay departures until their vessels are full and as such will face the possibility of unused capacity on every voyage. Moreover, modern containerships are large relative to demand for space aboard them. If the core of ocean liner shipping markets is indeed empty, it could explain at least some occurrences of excess capacity.

Other sources

A comprehensive study of excess capacity in liner shipping cannot ignore non-market influences. Restrictive trade policies, national ownership of carriers and direct and indirect operating subsidies each play an important role in determining the level of excess capacity. Such policies are prevalent in the liner shipping industry because the development and maintenance of viable maritime industry confers positive externalities on nations. First, shipping services enable countries to more fully extract the rents generated by international trade. Second, a substantial maritime industry is closely associated with geopolitical advantage, such as in times of war or national emergency. Given the benefits it is difficult for governments to resist the urge to create policies to allocate shipping services based on non-market influences.

Previous studies

There is a large theoretical literature on excess capacity as a deterrent to entry. Spence (1977), Dixit (1980), Eaton and Lipsey (1981), Kamien and Schwartz (1972), Gaskins (1971), Gilbert and Harris (1984), Shy (1995, pp. 186–192), Benoit and Krishna (1991), Bernheim (1984), Gilbert and Vives (1986), Waldman (1987), Wenders (1971) and Fox (1994) have each developed theoretical models on this topic. The common thread running through most of the literature on excess capacity as a strategic entry deterrent is that the behavioural perceptions about dominant firms can alter potential entrants' decisions. In other words, to successfully deter entry, the dominant firms' threat to increase output and intensify competition in the post-entry game, that is to 'play nasty' in the game theorist's language, must be credible.

Empirical work in this topic is relatively rare. None have revealed overwhelming support for the theory of excess capacity as an entry deterrent. The reader is referred to Masson and Shaanan (1986), Gilbert and Lieberman (1987), Lieberman (1987), Hilke (1984) Esposito and Esposito (1974) and more recently, Driver (2000).

Excess capacity on US trade lanes – Historical perspective

One of the most striking aspects of excess capacity in liner shipping is its persistence, even in the face of service rationalisation and government deregulation. In the 1990s and into 2001, liner shipping underwent a rash of consolidation and mid-way through 1999, the US implemented the Ocean Shipping Reform Act (OSRA), which permitted carriers to engage shippers in long-term service contracts. Deregulation and increased cooperation among carriers through vessel sharing agreements, global alliances and several large mergers and acquisitions should have increased operating efficiency and reduced excess capacity. But this has not been the outcome. In spite of all of these efforts, Figure 1 shows that excess capacity relative to total capacity on US inbound trade lanes has improved very little if at all over the past decade. Figure 2 shows that on US outbound lanes, excess capacity has slightly increased.

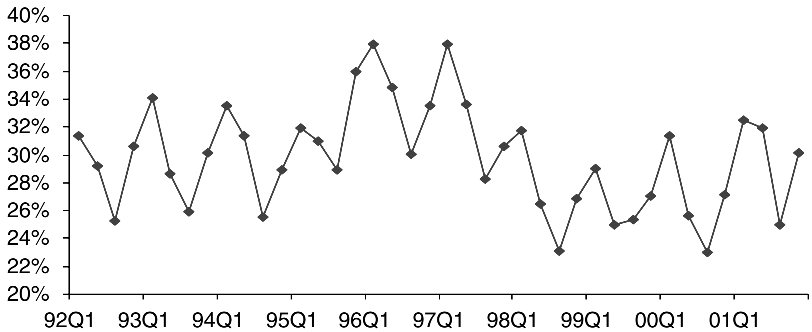

Figure 1: Excess capacity on inbound US trade lanes; percent of total capacity (1992–2001)
Source: PIERS

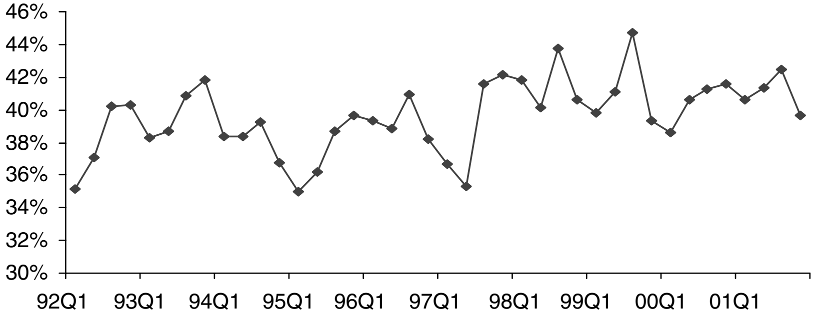

Figure 2: Excess capacity on outbound US trade lanes; percent of total capacity (1992–2001)
Source: PIERS

A model of strategic reserve capacity

In view of the persistence of excess capacity in liner shipping, it is not unreasonable to suspect that it may in part be motivated by strategy to preclude entry. The following model attempts to characterise how this strategy could contribute to excess capacity. There are two sectors in the market, dominant firms and fringe firms. Both compete in a Bertrand-like fashion such that the players in each sector believe that their actions can affect the behaviour of their rival. It is assumed that dominant firms maximise long-term profits, which requires them to maximise capacity utilisation on every voyage. Excess capacity is the only means by which dominant firms can forestall entry/expansion in the competitive fringe. This excludes the influence of product differentiation. Dominant firms seek to hold their market share fixed. Market share is a function of the level of capacity in each sector.

Output of both the dominant firms and the fringe firms is defined as service frequency offered per unit time. In particular, service frequency is defined as the total number of container 'slots' made available to shippers per unit of time, a function of the size of the carrier's fleet plus its level of technology. Whether those slots are filled with containers is irrelevant. If the ship makes a voyage it has 'produced' output in the form of the total number of slots it has made available to shippers. Slots not purchased are the excess of supply over demand or excess capacity.

The dominant firm production function measured as service frequency per unit time is assumed to be a linear function of its carrier's aggregate capital stock.

$$F_s^d(t) = \alpha K(t) \tag{1}$$

where $F_s^d(t)$ is the output (service frequency measured in slots per unit time) of dominant firms at time (t) and $K(t)$ is the aggregate capital stock. α is an efficiency parameter that indicates the dominant firm's level of technology. With respect to vessel operations α is an indicator of the aggregate technological sophistication of the vessel, that is, a combination of its fuel efficiency, navigation systems, or any other per unit cost savings input. The production function implicitly assumes constant returns to scale. The aggregate capital stock is a combination of the size of the fleet and all other capital equipment associated with producing output in liner shipping including terminal equipment, buildings that house management, sales and operations personnel, and so on.

Before proceeding, a distinction must be made regarding the short and long term. The short term is defined as an interval of time during which only the size and speed of the fleet can vary. The remaining components of the capital stock are assumed to be fixed in the short term. Hence the dominant firms' choice of capacity is necessarily a short-term response to fringe firm behaviour. The model assumes that dominant firms hold aggregate variable capacity in the form of productive capacity $K_p(t)$ plus its excess reserve capacity, $K_r(t)$. Hence dominant firm aggregate variable capacity is $K(t) = K_p(t) + K_r\ (t)$.

The production function in the fringe is also a linear function of its aggregate capital but unlike the case of the dominant group, it does not hold excess capacity. Its level of technology is imbedded in the parameter, β:

$$F_s^f(t) = \beta X(t) \tag{2}$$

In equilibrium, total market output is the sum of the dominant firms' output and the fringe firms' output:

$$F_s(t) = F_s^d(t) + F_s^f(t) \tag{3}$$

Taking the derivatives of equation (3) with respect to time yields

$$\frac{\mathrm{d}F_s(t)}{\mathrm{d}t} = \alpha \frac{\mathrm{d}K(t)}{\mathrm{d}t} + \beta \frac{\mathrm{d}X(t)}{\mathrm{d}t} \tag{4}$$

Frequency of service in the short term is identical to operating capacity, which is aggregate capacity in measured in TEU slots per unit time. In the dominant grouping, it evolves according to

$$\frac{\mathrm{d}K(t)}{\mathrm{d}t} = K(t) - sK(t) \tag{5}$$

where s is the vessel scrapping parameter or alternatively, a rate of depreciation of operating capital.

Fringe firm capacity is assumed to evolve based on the opportunity to capture excess demand:

$$\frac{\mathrm{d}X(t)}{\mathrm{d}t} = k[F_d(t) - K(t) - X(t)] \tag{6}$$

Equations (5) and (6) can be substituted now into equation (4):

$$\frac{\mathrm{d}F_s(t)}{\mathrm{d}t} = \alpha[K(t) - sK(t)] + \beta[k(F_d(t) - K(t) - X(t)] \tag{7}$$

Further substitution of the short-term variable capacity expressions yields equation (8).

$$\frac{\mathrm{d}F_s(t)}{\mathrm{d}t} = \alpha([K_p(t) + K_r(t)] + s[K_p(t) + K_r(t)]) + \beta[k(F_d(t) - K_p(t) - K_r(t) - X(t))] \tag{8}$$

At the optimal level of service frequency, the left hand side of equation (8) is zero. The solution for K_r is thus

$$K_r = \frac{\beta k}{\alpha - \alpha s - \beta k}[X(t) - F_d(t)] - K_p \tag{9}$$

Dividing both sides by $K_p(t)$ normalises the results.

It is not unreasonable to assume that $s = 0$. Hence the derivative of interest is

$$\partial(K_r(t)/K_p(t))/\partial(X(t)/K_p(t)) = \beta k/(\alpha - \beta k) > 0 \tag{10}$$

if dominant firm technology is greater than the product of fringe firm technology and fringe propensity to expand. If the propensity of the fringe to expand is equal to 0, then dominant firms hold no excess capacity since there the threat of entry is 0. As the propensity of the fringe to enter/expand rises, the level of dominant excess capacity is a function of their technology relative to the fringe. The more efficient dominant firms are relative to the fringe, the less excess capacity is required to hold market share fixed.

DATA

The model is designed to isolate strategic excess capacity from structural sources. Data will be pooled across trade lane and direction or trade (Table 1). There are two players in the market, dominant firms and a competitive fringe. In liner shipping it seems obvious that the dominant firms should be those engaged in conference agreements or discussion agreements. However, aside from the extreme practical difficulties of determining this structure over time, the work of Fox makes clear that conferences compete with each other as well as with the competitive fringe. For this reason, the dominant firms are defined as the leading two, three, four and eight firms in each market based on the share of container traffic carried in TEUs. Trade lanes are broken out by direction of trade. There are 20 panels in the data set. These include 10 trade lanes broken out by direction of trade.

Data is pooled across trade region and direction of trade. There are 20 panels with quarterly observations from the fourth quarter of 1991 through the

Table 1: Trade lane definitions

Trade lane	Description
Trans-Pacific	China, Taiwan, Japan, Korea, Hong Kong, Thailand, Malaysia, Indonesia, Singapore and The Philippines
Trans-Atlantic	All of Europe plus Turkey, Gibraltar, Cyprus and Malta
East Coast of South America	Brazil, Argentina, Venezuela, Uruguay, Paraguay, Suriname and Guiana
West Coast of South America	Chile, Peru, Ecuador and Colombia
Central America	Mexico south to and including Panama
Caribbean	All Caribbean islands not under United States governance
Oceania	Australia, New Zealand and all South Pacific Islands not associated with United States governance
Middle East/India and Other Asia	India and the subcontinent, the Persian Gulf and the rest of the Middle East except North Africa.
Africa	All Countries in Africa, including North Africa
Other	Canada, Greenland and various other territories in the Atlantic not under United States governance

fourth quarter of 2001, which yield a total of 740 observations. Fringe capacity is likely to be endogenous and as such will pose an estimation issue. While excess capacity of dominant carriers is hypothesised to be a function of fringe firm entry and expansion, it is also the premise of this model that fringe firm expansion is a function of dominant firm excess capacity.

Evidence of endogenous variables can be revealed with the Durbin-Wu-Hausman (DWH) test. The DWH test is an augmented regression test. In it, the suspected endogenous variables are regressed on all the exogenous variables in the model. The residuals are saved and used in a regression of the original model. If the errors are correlated, the *t*-statistics on the coefficient of the saved residuals of the suspected endogenous variable will be statistically different from zero. If the DWH test reveals evidence of endogenous variables, ordinary least squares (OLS) is not consistent. Instead, the model requires a two-stage estimation procedure. Either fringe firm capacity or dominant firms' concentration is first estimated as a function of all the exogenous variables in the model, and then the predicted values from those estimations are used to estimate the conference excess capacity equation.

The estimation approach will make use of random and fixed effects models with instrumental variables (IV). IV use the exogenous variables in the model to predict the values of the endogenous variable, or that variable thought to be closely related to the error term. All data is sourced from the PIERS database.

The equation to be estimated is the following:

$$\begin{aligned} PKE_{it} = {} & \alpha_1 + \alpha_2 * PKF_{it} + \alpha_3 * K_{it} + \alpha_4 * DD_{it} + \alpha_5 * IMB_{it} + \alpha_6 * OSRA \\ & + \alpha_7 * DVAR1QTR_{it} + \alpha_8 * AVG\_K_{it} + \alpha_9 * TIME \end{aligned} \tag{11}$$

PKE_{it} is the ratio of the sum of empty TEU slots per quarter among the dominant carriers in each market, to the sum of dominant carriers' productive capacity deployed per quarter. Dominant carriers shall be the top n carriers in each market based on TEUs carried. The model will be estimated for $n=2$, 3, 4 and 8. Productive capacity in each grouping is assumed to be equal to the sum of demand in each grouping, PKF_{it} is the ratio of fringe carriers' total capacity to dominant carriers' productive capacity, K_{it} is the sum of capacity held by dominant carriers in market i at time t, DD_{it} is total demand or TEUs shipped in market i at time t, IMB_{it} is the absolute value of the imbalance between imports and exports. The higher the trade imbalance, the higher will be the likelihood of excess capacity,

OSRA is a dummy variable for the Ocean Shipping Reform Act. It takes on a value of 1 after implementation in the second quarter of 1999 and 0 before. It is not the intention to incorporate OSRA as an all-encompassing policy impact variable, since that would require prohibitively exhaustive research on a global scale. However, OSRA may proxy for the impact of maritime policies of US trading partners since it was intended in part to create a 'more market-driven liner shipping industry' and as such may act as a counter-weight to restrictive policies among US trading partners. See Federal Maritime Commission (2000).

$DVAR1QTR_{it}$ is the quarter-to-quarter percentage change in demand and is meant to capture the effect on excess capacity of the volatility of demand,

AVG_K_{it} is the average capacity of containerships serving lane i at time t. This is a common measure of 'minimum efficient scale' (MES) by which industrial economists rate the probability of entry. The greater is MES, the lower the probability of entry since higher MES implies higher fixed (and perhaps sunk) entry costs. It is a function of technological change and as such may be closely correlated with the variable *TIME*.

TIME is a time trend meant to proxy for the effects of technical change, increased carrier cooperation through alliances and vessel sharing or other variables not directly incorporated in the model.

Since capacity of the fringe is likely to be endogenous, it will require a second equation composed of all the exogenous variables in the first equation plus an instrument(s) for the endogenous variable. The predicted values from this regression are substituted for the actual values in equation (11). The search for an appropriate instrument is a key element of simultaneous equations estimation. If the chosen instrument does not display a statistically significant relationship with the endogenous variable, the problem of weak instruments can produce biased results. See Bound *et al* (1995) for a discussion of the potential pitfalls of improper use of instrumental variables. In the case that fringe firm capacity is endogenous we have

$$PFK_{it} = \alpha_1 + \alpha_2 * K_{it} + \alpha_3 * DD_{it} + \alpha_4 * IMB_{it} + \alpha_5 * OSRA + \alpha_6 * DVAR1QTR_{it} + \alpha_7 * AVG\_K_{it} + \alpha_8 * TIME + \alpha_9 * VOY_{it} + \alpha_{10} * POSENTRY_{it} \quad (12)$$

In equation (12) there are two instruments: the dominant group's voyage count (VOY_{it}) calculated as the aggregate sum of the number of steamship lines and regions represented by a single vessel voyage in the dominant firm grouping; and net fringe entry ($POSENTRY_{it}$) defined as the net addition of a carrier in the market. It is likely that as the dominant group raises its number of voyages, either on its own or though use of partner vessels, the capacity of the fringe should decline. In contrast, $POSENTRY_{it}$ is likely to be positively related to fringe firm capacity unless new entrants operate with less capacity than those that are exiting.

In the random effects model, there is a single constant term that carries a distribution across panels. In the fixed effects model, differences across panels can be viewed as shifts in the constant term. The general form of a pooled time series model is $Y_{it} = a + Xb + v_i + e_{it}$. The errors have two components, v and e. The v component is the error associated with the i^{th} panel and the e is associated with both the panel and the time element. A random effects model assumes that the expected value of the v component is zero but the variance of $v > 0$. Otherwise, v would be a constant. The random effects model thus conserves degrees of freedom and as such is more desirable. To make the case for a random effects model, the Hausman test is available. The Hausman test provides a means of testing whether the coefficients obtained through the fixed and random effects models differ systematically. If they do not, then the random effects model, which conserves degrees of freedom, is appropriate. The test was run on each of the four groups of firms and did not reveal statistically significant differences in the coefficients at the 5% level. Hence, the random effects model will be suitable.

The results are reported below. They suggest that the top two, three and four dominant carriers react to entry and expansion of the competitive fringe; however, only in the case of the top four dominant carriers is the reaction statistically significant.

Judging from the results in Table 2, there is a positive and statistically significant reaction by dominant firms to fringe firm capacity expansion in the top four carriers grouping. The coefficient of 0.242 evaluated at the averages of PKE_{it} and PKF_{it} yields an elasticity of 0.763, falling in the inelastic range. While in the top two and top three groups the coefficient was of the expected sign, it was not statistically significant. The top eight firm grouping was neither

Table 2: Model results

Model/Variable	*Top 2*	*Top 3*	*Top 4*	*Top 8*
Constant	−0.006	0.019	0.035	0.451***
PKF_{it}	0.103	0.173	0.242**	−0.147
IMB_{it}	1.55e−07**	2.07e−07**	1.87e−07**	7.83e−08*
OSRA	0.020	−0.003	0.002	−0.004
$DVAR1QTR_{it}$	0.060	0.125	0.010	−0.053
TIME	−0.004*	−0.004*	−0.004**	0.0002
DD_{it}	−1.13e−06**	−1.23e−06**	−1.19e−06**	−3.32e−07
K_{it}	3.2e−06**	2.38e−06**	1.99e−06**	2.88e−07
AVG_K_{it}	0.00004	0.00004	0.00004*	2.52e−06
Wald-Statistic	65.26***	41.33***	35.54***	87.78***

* Indicates statistical significance at the 90% level, ** at the 95% level and *** at the 99% level.

statistically significant nor of the correct sign. The trade imbalance parameter was positive and statistically significant at least at the 10% level in each of the four groupings. The time parameter was negative in the first three groupings, suggesting that industry consolidation over the past 10 years has served to diminish the need for excess capacity as an entry deterrent. Moreover, *TIME* is likely picking up effects of increased use of vessel sharing arrangements that raise efficiency by rationalising space. The coefficient on demand was negative as expected since higher levels of demand naturally reduce excess capacity, particularly if it is unanticipated. This is indeed what the specification indicates. It was also expected that the absolute level of capacity in each group would raise excess capacity since liner shipping capacity is lumpy. This parameter was positive and statistically significant in each of the first three groups; however, it fails to explain much of excess capacity in the top eight grouping. This is likely because within the top four grouping financial resources are sufficiently large to incur the costs of adding larger ships than in the broader groupings. The results for absolute levels of capacity support the empty core approach since it suggests that capital lumpiness underpins a large proportion of the variance in dominant firm excess capacity. Simply put, when dominant firms deploy additional capacity, excess capacity necessarily rises since there is no way to precisely gauge the level of demand growth in a fixed schedule service. In this case, excess capacity created by the nature of liner shipping capital and its operations may deter entry incidentally, not necessarily as a deliberate strategy on the part of dominant firms.

The sign on the *OSRA* dummy was not different from zero in any of the groupings suggesting that this legislation has yet to have an impact on excess capacity among dominant firms. By permitting the use of confidential long-term contracting, OSRA would have been expected to reduce excess capacity since

Table 3: Strength of instruments

Instrument	*PFK2*	*PFK3*	*PFK4*	*PFK8*
$POSENTRY_{it}$	0.020	0.012	1.679	1.510
VOY_{it}	−0.001	−0.001	−0.001**	0.000

*Indicates statistical significance at the 90% level, ** at the 95% level and *** at the 99% level.

contracting can independently create a barrier to entry, particularly when information is asymmetric as in the case of confidential contracting. See Aghion and Bolton (1987) for a discussion of contracts as a barrier to entry. The sign on *AVG_K* was positive in the four-firm grouping and significant at the 90% level. Like K_{it}, this variable is picking up the effect on excess capacity of capital lumpiness and as such is further evidence of core emptiness. In sum, there is moderately strong evidence of preemption by means of excess capacity in the random effects model. Were preemption not an influence, the models would have produced negative or statistically insignificant result.

It is left to confirm the appropriateness of the instruments chosen to estimate the concentration and fringe firm equations. Table 3 reports the *OLS* results for the instruments in the first stage of the random effects model. Both instruments have the correct signs; however, the results indicate that only the voyage count is a strong instrument for fringe firm capacity and this in the four-firm grouping only.

CONCLUSION

Excess capacity is blamed in large part for the poor financial performance and economic inefficiency over the long-term history of the liner shipping industry. An attempt was made in this paper to differentiate and quantify excess capacity that may be the result of strategic behaviour among dominant carriers, and that which may emerge from the peculiarities of the industry, including its tendency towards natural monopoly and its lack of a competitive core.

A model of excess capacity as a strategic entry deterrent was constructed and then estimated using random effects with instrumental variables. The results suggest that strategic entry-deterring behaviour is an element of excess capacity in ocean liner shipping markets at the top four-carrier grouping. That is, the model presents evidence that the top four carriers in each market under study add excess capacity when a threat of entry or expansion in the competitive fringe is revealed. The excess capacity of dominant firms is meant to forestall fringe firm encroachment by saturating the market and reducing fringe firm profit opportunities.

But entry deterrence is of secondary importance to the theory of the core in explaining excess capacity in liner shipping. The primary determinant of excess capacity in liner shipping is the lumpiness of liner shipping capital. Additions to productive capacity in this industry are large relative to demand and must be made in discreet units. Simply put, when dominant firms add capacity to their markets, excess capacity necessarily rises. This condition may be tolerated by dominant operators because larger vessels capture economies of scale and thus provide lower units costs. This supports Telser's empty core approach in describing imperfectly competitive markets, and also lends credence to Sharkey's dynamic capacity expansion problem that characterises natural monopoly markets. Other indicators of natural monopoly, however, such as the trade imbalance between imports and exports, technical change and demand volatility fail to provide more universal support in the application of the theory of natural monopoly to liner shipping markets. In fact, there was no convincing evidence in this model that excess capacity is a result of natural monopoly at all, unless one believes that an empty core is synonymous with natural monopoly.

The implications of these results for maritime policy are predicated on the notion that excess capacity is necessarily inefficient, and that improving the flow of international liner trade requires that it be minimised. Any policy would necessarily be required to balance the interests of shippers and carriers. Shippers prefer excess capacity because it increases their choices and lowers their prices. The effect of excess capacity on carriers, however, is likely to raise its fixed costs and reduce its profits. Absent inefficient subsidies, this could eventually present a long-term threat to the viability of the industry in its current form. Instead, there is apt to be increased consolidation among dominant carriers seeking rationalisation of their capacity and subsequently an increased risk of anti-competitive behaviour that is detrimental to shippers.

First, it is clear that a certain level of excess capacity in liner shipping will have to be tolerated since it arises from the specific characteristics of the industry and the capital it employs. Container vessels are lumpy pieces of equipment that when deployed in a fixed and committed schedule, are unlikely to consistently operate at maximum load factors. That being said, the one real variable that policy can affect is entry. Inefficient entry, that is, entry that poses a competitive threat to dominant carriers without providing compensating benefits to shippers should be minimised. Efficient entry, on the other hand, should be encouraged. On the surface, this conclusion seems to be stating the obvious. Entry restrictions such as licensing fees can in theory provide an adequate response to inefficient entry. Maritime transport, however, confers positive externalities upon countries that operate liner services. Hence, enforcing such restrictions would require a consensus among international players with possibly disparate interests. The question then becomes, should an active policy on competitive entry be eliminated entirely? In other words, can the market itself be an adequate regulator of competition in liner shipping? Again, this would require that all countries form a consensus to adopt a policy of deregulation, including the elimination of any and all operating subsidies, national ownership of carriers, and the Liner Code of Conduct. In this case, the objective would be to force trade in maritime transport services to follow the ageless comparative advantage model of David Ricardo. A policy of this nature would also have to impose and strictly enforce antitrust rules in case deregulation causes a significant increase in market power of the suppliers.

REFERENCES

Aghion, P and Bolton, P. 1987: Contracts as a barrier to entry. *American Economic Review* **77**(3): 388–401.

Benoit, J and Krishna, V. 1991: Entry deterrence and dynamic competition: the role of capacity reconsidered. *International Journal of Industrial Organization* **9**: 477–495.

Bernheim, B. 1984: Strategic deterrence of sequential entry into an industry. *Rand Journal of Economics* **15**: 1–11.

Bittlingmayer, G. 1982: Decreasing average cost and competition: a new look at the Addyston pipe case. *Journal of Law and Economics* **XXV**: 201–229.

Bittling mayer, G. 1985: Did antitrust policy cause the great merger wave? *Journal of Law and Economics* **XXVIII**: 77–118.

Bound, J, Jaeger, DA and Baker, RM. 1995: When the correlation between the instruments and the endogenous explanatory variable is weak. *Journal of the American Statistical Society* **90**(430): 443–450.

Dixit, A. 1980: The role of investment in entry-deterrence. *The Economic Journal* **90**: 95–106.

Driver, C. 2000: Capacity utilization and excess capacity: theory, evidence and policy. *Review of Industrial Organization* **16**: 69–87.

Eaton, CE and Lipsey, RG. 1981: Capital commitment and entry equilibrium. *The Bell Journal of Economics* **12**: 593–604.

Esposito, FF and Esposito, L. 1974: Excess capacity and market structure. *Review of Economics and Statistics* **LVI**(2): 188–194.

Federal Maritime Commission 2000: The ocean shipping reform act: an interim status report. Staff Report.

Fox, N. 1994: An oligopoly model of ocean liner shipping. *Review of Industrial Organization* **9**(4): 343–357.

Gaskins, DW. 1971: Dynamic limit pricing: optimal pricing under threat of entry. *Journal of Economic Theory* **3**: 306–322.

Gilbert, RJ and Harris, RG. 1984: Competition with lumpy investment. *Rand Journal of Economics* **15**(2): 197–212.

Gilbert, RJ and Lieberman MB. 1987: Investment and coordination in oligopolistic industries. *Rand Journal of Economics* **18**(1): 17–33.

Gilbert, RJ and Vives, X. 1986: Entry deterrence and the free rider problem. *Review of Economic Studies* **53**: 71–83.

Hilke, JC. 1984: Excess capacity and entry: some empirical evidence. *The Journal of Industrial Economics*, **XXXIII**(2), 223–239.

Jansson, JO and Shneerson, D 1986: The effect of capacity costs and demand elasticities on the structure of liner freight rates. *Logistics and Transportation Review* **22**(1): 3–25.

Kamien, M and Schwartz, N. 1972: Uncertain entry and excess capacity. *American Economic Review* **69**(5): 918–927.

Lieberman, MB. 1987: Excess capacity as a barrier to entry: an empirical appraisal. *The Journal of Industrial Economics* **XXXV**(4): 607–627.

Masson, RT and Shaanan, J 1986: Excess capacity and limit pricing: an empirical test. *Economica* **53**: 365–378.

Pirrong, S. 1992: An application of core theory to the analysis of ocean shipping markets. *Journal of Law and Economics* **XXXV**: 89–131.

Sharkey, WW. 1982: *The Theory of Natural Monopoly*. Cambridge University Press: Cambridge.

Shy, O. 1995: *Industrial Organization.* MIT Press: Cambridge, MA.

Sjostrom, W. 1989: Collusion in ocean shipping: a test of monopoly and empty core models. *Journal of Political Economy* **97**(5): 1160–1179.

Spence, AM. 1977: Entry, capacity, investment and oligopolistic pricing. *The Bell Journal of Economics* **8**: 534–544.

Telser, LG. 1987: *A Theory of Efficient Cooperation and Competition*. Cambridge University Press: Cambridge.

Telser, LG. 1991: Industry total cost functions and the status of the core. *The Journal of Industrial Economics* **XXXIX**(3): 225–240.

Telser, LG. 1996: Competition and the core. *Journal of Political Economy* **104**(1): 85–107.

Waldman, M. 1987: Non-cooperative entry deterrence, uncertainty and the free rider problem. *Journal of Economic Studies* **LIV**: 301–310.

Wenders, JT. 1971: Excess capacity as a barrier to entry. *The Journal of Industrial Economics* **XX**(1): 14–19.