Academic perspectives on the feasibility of mega container ships

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ACADEMIC PERSPECTIVES ON THE FEASIBILITY OF MEGA CONTAINER SHIPS

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A SHORT HISTORICAL NOTE ON SCALE INCREASES IN VESSEL SIZE

Scale increases in container vessel size are a well-documented and much debated topic. The search for economies of scale and the focus on cost control have pushed the container shipping industry towards the deployment of ever larger containerships. In the early days of containerisation, ships had a nominal capacity of a few hundreds of TEU. In 1988, APL was the first shipping line to deploy a post-Panamax vessel. In 1996, Maersk Line shook the market by introducing the Regina Maersk of about 7,400 TEU. Consecutive rounds of scale increases led to the introduction of the 'Emma Maersk' in 2006, a containership which can hold more than 15,000 TEU and measures 397m length overall, a beam of 56 m, and a commercial draft of 15.5m. In 2013, Maersk Line led the next wave in scale enlargement by introducing the Triple E class (about 18,000 TEU). In the past few years, vessel capacity has been pushed beyond the 20,000 TEU mark, a trend initiated by COSCO Shipping (ships of up to 21,237 TEU), CMA CGM (up to 20,954 TEU) and OOCL (units of up to 21,413 TEU). The first Ultra Large Container Ships (ULCS) of 23,000 TEU were delivered in 2019. The world's largest container vessel at the time of writing was the HMM Algeciras with a capacity of just under 24,000 TEU. The introduction of ever larger container vessels has resulted in an overall upscaling across the main east-west trade routes, with big vessels also cascading to north-south routes.

THE FINDINGS OF EARLY ACADEMIC RESEARCH

The economic efficiency of ship size has been being researched since the early 1970s. The seminal work of Jansson and Schneerson published in 1987 pointed out that the optimal ship size represents a trade-off between the positive returns earned at sea (i.e. economies of size during the line-haul operation) and the negative returns accruing while in port (i.e. diseconomies of size during the handling operations in ports). In the late 1990s, numerous scholars demonstrated that port and terminal-related factors indeed have a large impact on the feasibility of deploying bigger vessels. A survey among container shipping lines conducted by Scottish economist Alfred Baird in 1999 showed that 78% of the respondents expected that containership sizes would not go beyond the 12,000 TEU threshold. When asked about the main operational barriers to the deployment of larger containerships, the shipping lines did not point to technical limitations or market obstacles but identified port and terminal related factors as the main impediments to further scale increases: low terminal productivity, port congestion, limited nautical accessibility, berth length, turning circles, to name but a few issues. In the late 1990s to early 2000s, academic studies seemed to agree that the 8,000 TEU ship was the optimal ship size on the Europe-Far East trade. The economies of size diminished very rapidly beyond the 5,000 TEU scale. For example, an analysis made in 2002 by the well-known maritime economist Martin Stopford revealed that, at that time, there were almost no economies of scale in bunker consumption.

RECENT ACADEMIC INSIGHTS

More recent research shows that economies of scale at sea do not stop at the 6,000, 8,000 or 10,000 TEU threshold as suggested in studies published 15 to 20 years ago. Economies of scale at sea seem not to have been fully exhausted, while ports, terminals and entire transport systems have been expanded and upgraded to significantly reduce possible diseconomies of scale in ports. The adaptive capacity of the port and terminal industry in terms of investments and productivity/efficiency gains typically did not result in a penalization of larger vessels through port and terminal pricing. Advances in port productivity have resulted in a disproportionately lower growth of port turnaround time as a function of vessel size. In other words, one could argue that the potential diseconomies of scale linked to larger vessels have been fully or partially absorbed by port authorities, terminal operators and other actors in the chain, thereby enabling/facilitating shipping companies to pursue consecutive rounds of scale increases in vessel size.

Still, further benefits of lower slot costs lessen while ships get larger and savings might not even be (fully) realized. The necessary efforts to prepare ports and terminals for ships of ever-increasing size are growing disproportionally. Supply chain risks related to bigger containerships could rise. Thus, it seems to become increasingly difficult to bring any further benefits for the shipping lines, the ports/terminals and the shippers when pursuing further scale increases in ship size (for example on the Europe-Far East trade).

THE GREEN ARGUMENT FOR FURTHER SCALE INCREASES IN VESSEL SIZE

More recent studies also pay attention to emission reduction and energy saving associated with ship size. In 2019, a study by Cariou, Parola and Notteboom published in International Journal of Production Economics identified the key factors contributing to recent reductions in CO_2 emissions by container shipping on a worldwide scale. Scale increases in vessel size combined with advances in ship technology and slow steaming were found to be among the most significant contributors to the general decrease in annual CO_2 emissions of the world containership fleet between 2007 and 2016. Container shipping is increasingly confronted with stronger environmental considerations and stricter regulatory frameworks on ship emissions and energy efficiency such as MARPOL Annex VI (Regulations for the Prevention of Air Pollution from Ships) and monitoring, reporting and verification (MRV), the Emission Control Areas (ECAs), the global sulphur cap of 0.5% (applicable since 1 January 2020) and the Energy Efficiency Design Index (EEDI), mandatory for new ships since 2013.

A lot of research has been conducted to compare several emission control projects and their economic viability, such as new energy adoption (such as the use of LNG, hydrogen), low sulphur bunker fuel, dual fuel and technical retrofitting by installing emission control devices such as scrubbers and selective catalytic reduction (SCR) systems.

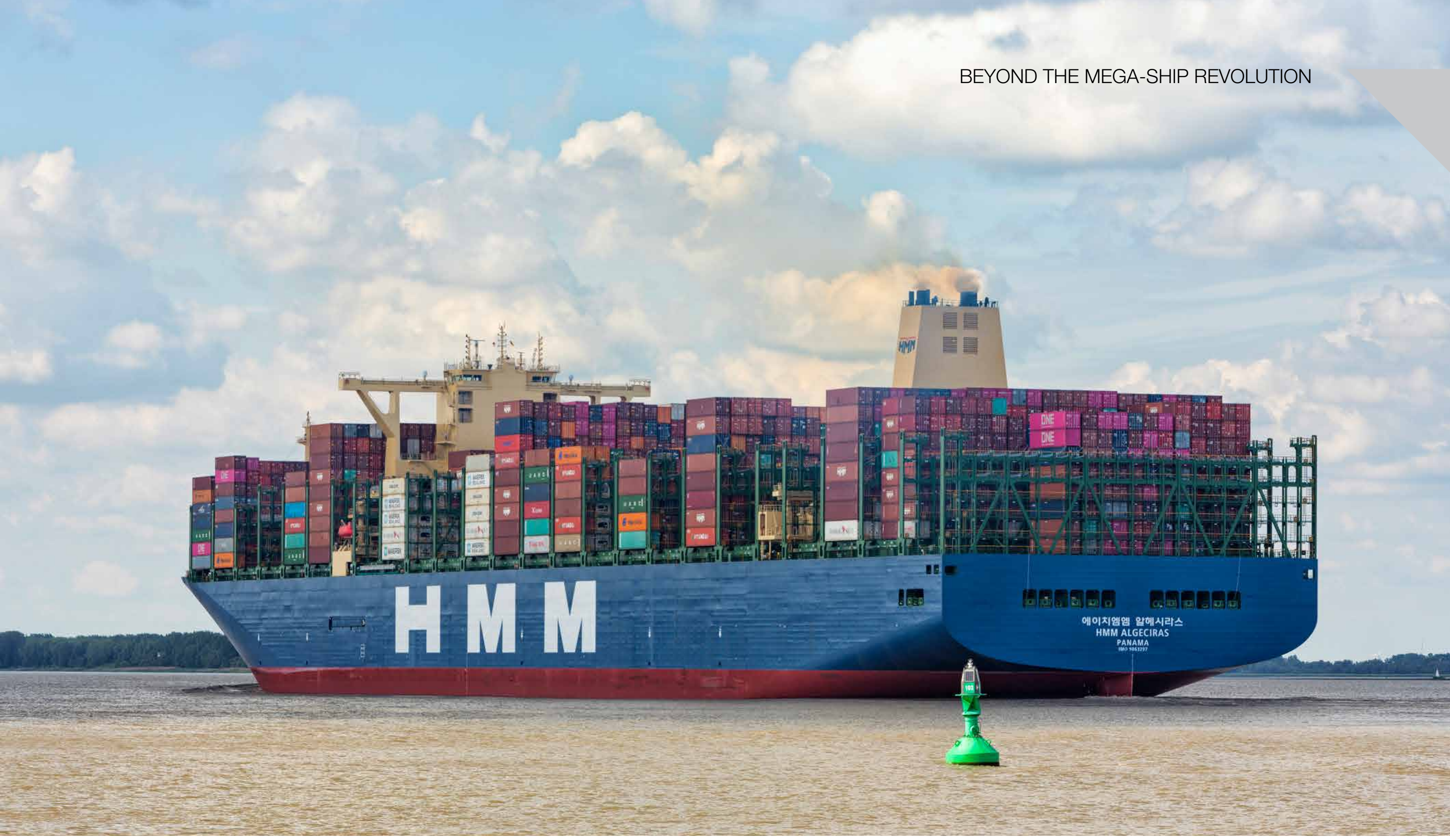
Container carrier CMA CGM was the first to order ULCSs with engines using LNG. These ships are estimated to emit up to 25% less CO_2, 99% less sulphur emissions, 99% less fine particles and 85% less nitrogen oxides emissions compared to ships using heavy fuel oil (HFO). The first of the fleet, the CMA CGM Jacques Saade joined the fleet in September 2020. Many shipping companies opted for retrofitting of existing ships partly driven by the uncertainty related to the future prices and availability of alternative fuels. Quite a few retrofitting operations were executed earlier this year when many ships were idled as a result of blank sailings.

THE FEASIBILITY OF SCALE INCREASES CHANGES WITH TIME AND THE MARKET CONTEXT

The above discussion of existing literature with respect to ship size makes clear that the evaluation of the effects of scale increases in vessel sizes is multi-facetted and complex. The outcome of any analysis on (dis)economies of scale and optimal vessel scale seems to be context- and time-dependent.

For example, the economic viability of deploying ships of more than 10,000 TEU was considered weak in the late 1990s. However, weak market conditions in the post-2009 era, combined with a strong adaptive capacity of ports and terminals to accommodate bigger vessels, have helped shipping lines to order larger vessels, so as to improve firm and environmental performance.

"THE NECESSARY EFFORTS TO PREPARE PORTS AND TERMINALS FOR SHIPS OF EVER-INCREASING SIZE ARE GROWING DISPROPORTIONALLY."



A recent academic paper by Jiawei Ge and others (see reference at the end of this contribution) presented an economic analysis of different mega ship sizes (units of 18,000; 20,000 and 25,000 TEU). The focus was on a comparison of unit (slot) costs and more comprehensive cost-benefit measures such as the net present value (NPV). The study evaluated whether there are economic, operational and environmental justifications for shipping companies to push the ULCS size from 18,000-20,000 TEU to 25,000 TEU considering the current and expected market conditions on the Europe-Far East trade and the current and expected environmental context for ship operations. The study came to the following conclusions:

- A further scale increase to a 25,000 TEU ULCS still generates economies of scale. Even under weak market conditions, the 25,000 TEU option gives a slightly better NPV result that the other two ship options, while the annual unit cost advantage for the largest ship size is more pronounced. Strong market conditions lead to positive NPVs for all three size options, but the 25,000 TEU ULCS clearly shows the best results.
- Changes in freight rates and load factors have the highest impact on the NPV results. Very low freight rates, i.e. even below the poor freight rates of 2016, are not beneficial to the economic viability of 25,000 TEU ships compared to the other two ship types. Higher rates give a strong incentive to shipping lines to order the largest ULCS possible.
- Very low load factors make the 18,000 and 20,000 TEU units more competitive from an NPV perspective, while the balance tilts to the 25,000 TEU unit when higher load factors are achieved.
- The NPV results are also very sensitive to vessel speed. When super slow steaming is applied, the NPV values of the three ship sizes remain very similar. However, the 25,000 TEU vessel can present more favourable NPV results than the other two ship sizes when a sailing speed above 17 knots would be adopted, which remains unlikely in the current market context.
- A fall in shipbuilding prices and bunker prices makes the 25,000 TEU ship slightly better off compared to the other two ship types.

Note: This contribution is partly based on the in-depth discussion on the economic feasibility of mega container vessels in “Ge, J., Zhu, M., Sha, M., Notteboom, T., Shi, W., Wang, X., 2020, Towards 25,000 TEU vessels? A comparative economic analysis of ultra-large containership sizes under different market and operational conditions, Maritime Economics and Logistics, online first, https://doi.org/10.1057/s41278-019-00136-4 ”

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