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The impact of slow steaming on the carriers' and shippers' costs: The case of a global logistics network

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ABSTRACT

We propose an analytical modeling methodology for quantifying the impact of slow steaming on the carrier's voyage cost and on the shipper's total landed logistics costs. The developed methodology can be employed by a carrier and a shipper in their contract negotiations, in order for the two parties to determine how they could divide between them the savings resulted from slow steaming. We demonstrate that the impact of slow steaming and speed adjustment policies on the shippers' total landed logistics costs tend to increase as the vessel travels towards the end of its voyage.

1. Introduction

The world fleet grew by 3.5% throughout 2015. This is the lowest growth rate since 2003, yet still higher than the 2.1% growth in demand, leading to a continued state of global overcapacity (UNCTAD, 2016). Tracking this trend in time, in 2008 orders for bulk carriers reached more than six times the average of the orders placed in the period between 1980 and 2006, indicating that the shipping sector was at the peak of its economic cycle and its subsequent downfall was imminent (Haralambides and Thanopoulou, 2014). However, despite this alarming indicator, ship owners continued placing orders for the production of new vessels. To that effect, for the 2007–2008 period and even though ship prices were at their peak, $400 billion worth of additional ship orders were placed (Stopford, 2010; UNCTAD, 2013).

As the U.S. banking crisis of 2008 led to a global recession and a downturn of global trade, a significant surplus of ship capacity had already been built, further exacerbated as preceding ship orders were being manufactured and new ships entered the market (Haralambides and Thanopoulou, 2014).

In this troublesome environment, carriers face two critical bottlenecks. The first one involves the reduction of their ship-operating costs in order to sustain their profitability and market share in a market with low recovery rates of global demand (UNCTAD, 2013). The second one involves the utilization of their excess idle vessel capacity, due to the global transport demand downturn. This has been a stagnant problem for the shipping industry affecting negatively the level of the ocean freight rates charged to shippers (Wu, 2009).

Under this context, carriers adopt the practice of slow steaming, which involves the reduction of their vessels' speed for reducing fuel consumption (Sanguri, 2012). As fuel costs represent as much as 50–60% of total vessel voyage costs (World Shipping Council, 2008), it is interesting to state that the increase of a vessel's speed by a couple of knots, that is from 17 to 19 knots, 20–22 knots and 23–25 knots, leads to the consumption of almost 50% more fuel per unit of distance travelled (Lee et al. 2015). Thus, slow steaming

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provides significant potential for voyage cost reductions. Moreover, as the employment of slow steaming prolongs the ship's voyage duration, and since container demand is accumulated during the extended voyage duration, carriers have the flexibility to incorporate their idle ship capacity in their serving routes in order to improve delivery efficiency (Maloni et al., 2013).

Furthermore, under layday clauses, carriers must reach a port of loading till a predefined time schedule (Raunek, 2015), while during the vessel's voyage, delays may occur due to adverse weather conditions as the vessel sails, or at ports and canals due to congestion and port inefficiencies. On this basis, slow steaming provides carriers with the flexibility to increase their sailing speeds after a delay occurs in order to cover all or as much of the delay possible in order to meet the layday.

To that effect, the employment of slow steaming under speed adjustment can have the following cost implications for the carrier: (i) reductions of voyage fuel costs; and (ii) increases of operating costs as the duration of the voyage increases.

With respect to the shipper, the employment of slow steaming under a vessel's speed adjustment policy may lead to: (i) lower safety stock holding costs, as the carrier's speed adjustment reduces the variability of the shipper's lead-times, and (ii) increases of the shipper's pipeline inventory holding, cycle stock, and backorder costs as the lead-time of order replenishments increases. As the lead-times also increase, when the voyage distances increase, it is intuitively sound that these cost impacts also depend on the voyage distance that the carrier must cover in order to replenish the shipper's orders. Thus, long voyage distances lead to higher shipper's pipeline and cycle stock costs, but they also provide more flexibility to the carrier to compensate voyage delays by adjusting the vessel's speed, and thus reduce the variability of the shipper's lead-time. It is therefore pivotal to be able to quantify the cost impact of slow steaming on the logistics costs of shippers at all intermediate ports of a shipping network, as the distances travelled by the carrier for replenishing their orders differ.

Under this context, the purpose of this paper is to develop an analytical methodology which provides estimates of the expected cost impacts of slow steaming under speed adjustments for both the carrier and the shipper. This methodology can be employed by the carrier and the shipper in order to quantify the impact of slow steaming on their costs and thus, further be employed for contract negotiations.

To tackle the above, we adopt the following methodological steps as summarized below:

- We estimate the stochastic vessel's voyage duration under various slow steaming speeds, at each intermediate port of a shipping line network, while tackling voyage delays at each intermediate port through higher speed adjustments of the vessel after the delay occurrence.
- We employ the stochastic voyage durations for appropriately selecting the vessel's slow steaming speeds (that lead to similar line efficiency) and further incorporate them in an activity based voyage cost model for estimating the carrier's voyage costs per container till each intermediate port.
- We incorporate the stochastic voyage duration till all intermediate ports and for each slow steaming speed into a continuous review (Q, R) inventory planning policy; this policy is selected since it provides a better synchronization with the OEM, and allows the estimation of the total landed logistics costs per container of each intermediate port's shipper, while encompassing on-hand and pipeline inventory holding costs, backorder, and facility operating costs.

The contributions of our proposed methodology are listed below:

1. In contrast to the majority of academic research efforts that employ simulation-based methodologies, we develop continuous-time analytical models for capturing the impact of slow steaming on the carrier's and the shipper's costs. We do that by considering a real-world policy used extensively by carriers today, namely the vessel's speed adjustment for recovering voyage delays at intermediate ports of a shipping network.
2. Delays at the intermediate ports of a shipping network are stochastic random variables and are entered in our modelling methodology based on real-world data. The existing research efforts instead, consider predefined distributions of the delay for their modelling purposes. Moreover, the delays considered in our modelling methodology consist of the delays during the voyage and at the ports, in contrast to the majority of the academic research efforts that only consider delays at ports.
3. Our modelling methodology includes specific inventory planning policies, while providing an analytical solution for minimizing the shipper's total landed logistics costs under slow steaming. On the other side, the existing research efforts mainly employ simulation-based methodologies for minimizing the shipper's safety stock and pipeline inventory holding costs.
4. We obtain important managerial insights from the implementation of the developed methodology on a rather extensive realistic case of a shipping line from China to Europe and back to China, while the majority of existing research works employ simple numerical examples.

The rest of the manuscript is organized as follows. In Section 2, we present a critical taxonomy of the existing research efforts encountered in the literature focusing on the application of modelling methodologies for quantifying the impact of slow steaming. Section 3 describes the problem under study, while Section 4 presents the proposed modelling methodology for quantifying the impact of slow steaming on the carriers' and the shippers' logistics costs. More specifically, Sections 4.1 and 4.2 present the modelling methodologies employed for quantifying the impact of slow steaming on the vessel's voyage duration, and for selecting the carrier's appropriate slow steaming speeds respectively. Section 4.3 determines the shipper's cost. Section 4.4 presents the model employed for quantifying the impact of slow steaming on the carrier's costs. Section 5 illustrates the applicability of the proposed modelling methodology through the case study of a global logistics network; it further provides an extensive numerical investigation, while discussing interesting managerial insights. Finally, in Section 6 we sum-up the findings of this research.