The link between economy and environment in the post-crisis era: lessons learned from slow steaming

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Abstract: The crisis in shipping during the last years was synonymous with low demand for transport, low freight rates and high bunker prices. Sailing at speeds lower than the design speed reduces total fuel consumption resulting in bunker cost savings. Therefore, during the crisis slow steaming has been extensively exercised and some modern vessels were operating at half of their design speed. Given that fuel costs and emissions are directly proportional to one another (both being directly proportional to fuel used), it appears that reducing both could be a straightforward way towards a ‘win-win’ solution. Thus, this paper discusses the lessons learned by slow steaming providing the link between economy and the environment which is fundamental towards sustainability in shipping.

Keywords: slow steaming; sustainability; economy and environment.


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1 Introduction

Shipping is an old history that is pervaded by market cycles (Stopford, 2009). Everyday shipping companies face the challenge of navigating their way through the booms, recessions and depressions that characterise the shipping industry. Although the shipping industry is indeed used to market cycles and a recession was expected, especially after the strong boom that ended in 2008, this particular crisis was a real shock.

In late 2008, the world faced a financial crisis and, soon after, the first and deepest drop in the global output since the 1930s was witnessed. The world gross domestic product (GDP) felt by 1.9%. Furthermore, the United Nations Conference on Trade and Development (UNCTAD) estimated that the world merchandise export volumes have plummeted by 13.7% (UNCTAD, 2011). It is known that sea transport is a derived demand where shipping demand occurs as a result of seaborne trade. Thus, inevitably, world seaborne trade volumes felt by 4.5%. However, the crisis in shipping was not only due to low demand. On the supply side, in 2007 and 2008, a huge increase on the order book has been witnessed following the boom just before the crisis. At the beginning, not all ship types felt this slump in the same proportion. Seriously affected were bulk carriers and containerships. Tankers had a rough ride in early 2009. In the beginning of 2011, there seems to be some light at the end of the tunnel. For example, container shipping has managed a complete turnaround mainly due to the upturn in Asia and by sailing at slower speeds, which is the topic of this work. There is still a long way to go especially since bunker prices are rising again. One of the practises heavily utilised during the crisis that of slow steaming, is here to stay.

The organisation of the rest of this paper is as follows. Section 2 presents the reasons why shipping companies may have their vessels slow steaming. Next section describes the effects of speed reduction on the total trip time, fuel consumption, air emissions and bunker costs. Section 4 deals with the practical aspect of slow steaming and comments on the optimisation of speed by shipping companies, the initiative of ‘virtual arrival’ in the tanker sector and the ongoing work of the Baltic and International Maritime Council (BIMCO) to draft a clause for shipping contracts that can be used in the dry cargo and tanker trades. The final section concludes the paper with a summary of the above and a short discussion.

2 Taxonomy of speed reduction incentives

The reason for all these companies having their vessels running in slow speeds is mainly twofold: fuel costs and emissions. Given that fuel costs and emissions are directly proportional to one another (both being directly proportional to fuel used), it would appear that reducing both would be a straightforward way towards a ‘win-win’ solution. In an operational setting, one of the obvious tools for such a simultaneous reduction is speed: sail slower and you reduce both emissions and your fuel bill.

In theory, slow steaming is implemented due to many reasons. The two most important ones to reduce sailing speed are the need to cut-off emissions and to save money, mainly bunker costs. The main incentives for speed reduction are:
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1. higher or volatile bunker prices leading to increased fuel costs
2. higher bunker costs due to the need for using the more expensive LSFO, e.g., when operating in sulphur emission control areas (SECAs)
3. savings in other running costs components (e.g., port dues and local taxes).
4. overcapacity resulting to reduced freight rates
5. mandatory emission-related regulations
6. voluntarily emission-related regulations mainly adopted by companies that want to take responsibility for its impact on society.

2.1 Fuel prices

The push of high fuel prices to slow steaming is not new. In 1972, the price of crude oil was about $3 per barrel. As a result of the Yom Kippur War (1973) several Arab exporting nations imposed an embargo on countries supporting Israel. As a result, by the end of 1974, the oil price had quadrupled to over $12. The second oil crisis came with the combination of the Iranian revolution and Iraq-Iran war that caused oil prices to increase from $14 in 1978 to $34 per barrel in 1981.

Even in non-volatile markets, fuel costs are increased by the need to use more expensive fuel, see for example, the need to use low sulphur fuel oil (LSFO) in special areas. For example, the MARPOL Annex VI regulations set a global sulphur cap reduced initially to 3.50%, effective 1 January 2012; then progressively to 0.50%, effective 1 January 2020 (IMO, 2008a). Furthermore, in 2009, the Californian Air Resource Board (CARB) has enforced the use of diesel oils (MDO) or gas oils (MGO) in Californian waters. In addition, when in berth in EU ports, vessels must as of 1 January 2010 use marine fuels with a sulphur content not exceeding 0.1% by mass (EU directive 2005/33/EC, Article 4a).

‘Cleaner fuel’, which in most cases means ‘more expensive’ fuel, induces ship operators to investigate possible ways to reduce fuel consumption. Finally, note that an increase of fuel price will be the case if a carbon tax or an emissions trading scheme is implemented in shipping.

2.2 Savings in other running costs components (e.g., port dues and local taxes)

The two busiest ports in the USA (Long Beach and Los Angeles) have introduced a series of voluntary incentive-based programmes. Among others, the two ports offer a 15% discount on dockage fees to vessels that voluntary comply with the SPBP-OGV1 Vessel Speed Reduction Programme and reduce their speed to 12 knots within 20 nm of Point Fermin while entering or leaving the ports (The Port of Long Beach, 2009). Reduced port dues are not new; approximately 20 out of a total of 52 ports, back in 1992, had introduced environmentally differentiated port dues (Kågeson, 1999). However, probably the most famous incentive is the so called Green Award. Nowadays, the Green Award (2009) has become an independent foundation. A ‘green’ certificate is received by ship operators who have fulfilled some specific environmental and safety standards and that not only confirms the high quality of the vessel contributing also to a positive image for the company but also entails some advantages such as reduced port fees.
In addition, there are a couple of local regulations on taxes due to ship emissions. For example, on November 2006, the Norwegian National Parliament agreed to implement a new tax on NOx emissions from ships sailing between Norwegian ports. Tax is calculated using the consumed amount of fuel in tons, thus any speed reduction in inland waters entails lower taxes.

2.3 Reduced freight rates and overcapacity

Back in 1997, Lloyd List’s (1997) reports that tanker owners “adopted drastic measures, including scrapping, layup and slow steaming, to stay afloat” due to the overtonnaged tanker sector as a result of the new buildings book of the early ‘70s. It is not a coincidence that speed reductions are currently being heavily observed within the container market. Overcapacity has resulted in reduced freight rates, see Figure 1.

Figure 1  Time charter rate ($/day) for containerships (see online version for colours)

This has in turn enabled speed reductions. Figure 2 shows the numbers of vessels delivered and in order as of the beginning of each quarter from 1996 to 2009. As it can be seen many ships are to be delivered in the next two or three years in an overcapacity of the container market. However, it is not easy to guess the consequences of this oversupply since we cannot predict the trend in demand. Note that lately due to slow steaming many companies had to add more ships in their routes to maintain throughput (see for example, the additional ships deployed in the Far East – North Europe routes). This can, however, lead to higher time charter rates.
2.4 Mandatory emission-related regulations

Although some regulation exists for non-GHGs, such as SO₂, NOₓ and others, shipping has thus far escaped being included in the Kyoto global emissions reduction target for CO₂ and other GHGs (such as CH₄ and N₂O). In the near future, there is no doubt that CO₂-emissions related regulations will be implemented with speed reduction seen as the easiest way to comply with them. Currently, IMO is about to finalise a mandatory energy efficiency design index (EEDI) of the environmental performance of new ships. The same is true for the energy efficiency operational indicator (EEOI), which will be applicable to all ships. Without going into technical details, both indices are ratios, in which the numerator is a function of all energy consumed by the ship, and the denominator includes the ship’s operational speed. This means that the slower the ship goes, the higher both these indices will be, and the higher the ship will be ranked in terms of energy efficiency, both for design and for operation.

2.5 Voluntary emission-related regulations

Many shipping companies regularly publish social and environmental reports. Some of them are A.P. Moller – Maersk Group, Wallenius Wilhelmsen, NYK Line Japan and K-line. It is not a coincidence that companies engaged in the container market are among...
the most active ones. A reason may be the fact that containerships have been accused as the biggest polluter in shipping, see Psaraftis and Kontovas (2009a) for more.

All these voluntary activities fall into the so-called ‘corporate social responsibility’ (CSR). CSR is a form of corporate self-regulation integrated into the business model http://www.en.wikipedia.org/wiki/Business_model where such a policy should function as a built-in, self-regulating mechanism whereby business would monitor and ensure its adherence to law, ethical standards, and international norms. It is recognised that although the prime responsibility of a company is generating profits, companies can at the same time contribute to social and environmental objectives. However, some companies are accused to distract the public from ethical questions posed by their core operations and CSR programmes are exercised for the commercial benefit the companies enjoy through raising their reputation with the public or with government. The reader is referred to Schreck (2009) for more information on CSR. Regardless what the reason is, any voluntary measure that reduces the impact on environment should be more than welcomed.

3 Speed reduction as an operational measure

3.1 Literature review

We start by stating that even though the literature on the broad area of ship emissions is immense, the literature on the specific topic (link between emissions and maritime logistics) is scant, although steadily increasing during the last few years. The relevant literature can be divided into two main categories: one that deals with the impact of slow steaming in emissions reduction and bunker fuel savings and the other with determining the optimal speed in order to satisfy various criteria including minimising the operating costs.

There are a number of papers that consider the impact of speed reduction, especially, for container vessels. Andersson (2008) considered the case of a container line where the speed for each ship reduced from 26 knots to 23 knots and one more ship was added to maintain the same throughput. Total costs per container were reduced by nearly 28%. Eefsen (2008) considered the economic impact of speed reduction of containerships and included the inventory cost. Cerup-Simonsen (2008) developed a simplified cost model to demonstrate how an existing ship could reduce its fuel consumption by a speed reduction in low and high markets to maximise profits. Corbett et al. (2009) applied fundamental equations relating speed, energy consumption, and the total cost to evaluate the impact of speed reduction. They also explored the relationship between fuel price and the optimal speed. Notteboom and Vernimmen (2009) deals with the impact of high fuel costs on the design of liner services on the Europe-Far East trade and discuss the way that shipping lines have adapted their schedules in terms of speed and number of vessels deployed for each loop. Furthermore, a cost model is developed to estimate the impact of the additional bunker cost on the operational costs and cost comparisons for different vessel sizes and vessels speeds are presented. Cariou (2011) investigates slow steaming strategies especially in liner shipping and measures the reduction of CO₂ achieved in various container trades. In addition, the paper concludes that for the main trades speed reduction is cost beneficial when bunker price is at least $350 to $400 per tonne. Ronen
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(2011) studies the effect of oil price on the trade-off between reducing sailing speed and increasing the fleet size for container ships and develops a procedure to identify the sailing speed and number of vessels that minimise the annual operating costs.

In addition, the effect of speed reduction has been extensively investigated by the authors of this paper. Psaraftis and Kontovas (2009b) investigated the simple scenario where a fleet of N identical ships (N: integer), each of capacity (payload) W loads from a port A, travels to port B with a known speed, discharges at B and goes back to port A in ballast, with a known speed. The main result of the analysis was that total emissions would be always reduced by slowing down, even though more ships would be used. Psaraftis et al. (2009) focused on the case where total trip time was kept constant. Furthermore, Psaraftis and Kontovas (2010) took a look at various tradeoffs that are at stake in the goal for greener shipping and may impact the cost-effectiveness of the logistical supply chain and presented models that can be used to evaluate these tradeoffs.

On the other hand, a closely related area is that of the optimal speed, see also Section 4.1. Bunker costs are directly proportional to fuel consumption which is a mainly affected by speed. Given that bunker costs are the major portion of total operating costs the issue of optimal speed is of extreme importance.

To that extent, Alderton (1981) presents a variety of criteria to determine the optimal speed to maximise profit per ton carried and profit per day and discusses how sensitive these speeds are to such constraints as port time, voyage distance and bunker costs. Benford (1981) proposed a simple procedure to select the mix of available ships form a fleet and their sea speeds in order to achieve the maximum profitability for a fleet owner. Perakis (1985) found that the work of Benford (1981) imposed an artificial constrained by assuming the capacity being proportional to the speed and by not taking into account lay-up costs. Thus, Perakis (1985) relaxed some assumptions and arrived at an optimal solution that reduced by 15% the operating costs compared to that of Benford (1981). Ronen (1982) presented three models for the explicit determination of the optimal speed, namely for the ballast (or positioning) leg, the income generating (or laden) and the mixed one, and analysed the trade off between fuel savings through slow steaming and loss of revenues due to the increase of voyage time.

As focus moves from assessing the optimal speed for a single vessel to that of a fleet of vessels, the perspective changes. For a literature review on relevant problems, such as fleet deployment and ship scheduling, the reader is referred to Christiansen et al. (2007).

3.2 The impact of speed reduction on total trip time

Our generic approach assumes a vessel that departs from port A and arrives at port B, probably after visiting a number of ports in between. The vessel covers a total distance of L nm from A to B carrying a payload W with an average (or constant) speed of $V_0$ (in knots). Port B can be the same with port A – in that case we are talking about a roundtrip. We also assume that fuel consumptions are known although it could be also roughly estimated based on the installed power of the vessel.

We will first investigate the impact of speed reduction on total time. The time that the vessel spends at sea depends only on speed while time at port depends on many factors, such as amount of cargo to be handled, loading and unloading speed, etc. For the time being, we assume that the time in port is known.

The times that the vessel spends at sea and in port are expressed as follows:
At sea total time at sea \( T_0 = \frac{L}{24 \cdot V_0} \) (days)

In port total time in port \( t_0 \) (days).

Now, suppose that the ship operator wants to investigate the scenario of speed reduction. Reducing speed means that the ship will now sail at a new speed \( V \) which will be a fraction of the original speed \( (V = aV_0 \text{ where } 0 < a < 1) \) and, hence, there will be an increase of the time at sea as follows:

\[
T = \frac{L}{24V} = \frac{T_0}{a}
\]

It is obvious that if time in port remains the same (port time difference \( t - t_0 \) equals to 0) there will be a need to add a number of additional vessels (possibly fractional) in order to maintain the same throughput per year. That is the case, especially, for liners. In theory, even if more ships are added in a specific route, it could be proven that this is beneficial for the operator (but only in terms of bunker costs alone). Whether or not speed reduction is overall more profitable to the operator depends also on the additional costs of deploying the extra vessels. In addition, speed reduction will also entail increased in-transit inventory costs, to be borne by the charterer, and these are proportional to the value of the cargo. For an analysis of related scenarios see Psaraftis and Kontovas (2009b, 2010).

Reducing time in port may be one way to keep a constant total trip time. It should be realised that reducing port time may not be possible, as this would depend on a variety of factors that may concern either the ship, or the port itself, or both. But if time in port can be reduced at all, it can be a crucial factor to reducing ship total emissions. An attempt to investigate such scenarios was done in Psaraftis et al. (2009) and Kontovas and Psaraftis (2010).

### 3.3 Effect on fuel consumption

In the above scenario the daily fuel consumption and the time in port are assumed known. Furthermore, the time that the ship spends at sea can be calculated given that distance and speed are known. Thus, the following are known:

<table>
<thead>
<tr>
<th>At sea</th>
<th>In port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel consumption ( F_0 ) (tonnes per day)</td>
<td>Fuel consumption ( f ) (tonnes per day)</td>
</tr>
<tr>
<td>Total time at sea ( T_0 = \frac{L}{24 \cdot V_0} ) (days)</td>
<td>Total time in port ( t_0 ) (days)</td>
</tr>
</tbody>
</table>

The total fuel consumption for this trip is \( FC_0 = F_0 \cdot T_0 + f \cdot t_0 \)

In the relevant literature, for such small speed reductions the effect of speed change on fuel consumption is assumed cubic for the same ship. Note that, in principle, the fuel consumed has to do with the power needed to achieve a specific speed. This means that it also depends on the vessel’s displacement and weather conditions. In reality, no relationship between fuel consumption and speed exists, however, the cubic law can be used for rough approximations. Generally speaking, the fuel consumption at the reduced speed \( F \) can be approximated as follows:
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\[ \frac{F}{F_0} = \left( \frac{V}{V_0} \right)^n \]
given that \( F_0 = kV_0^n \), where \( k \) and \( n \) are known constants.

In this paper, reductions in fuel consumption, emissions and bunker cost will be presented as a function of \( n \). We can compute the difference in fuel consumption for the above scenario as follows:

- **At sea:**

\[
\Delta(\text{consumption at sea}) = F \cdot t - F_0 \cdot t_0 = F \cdot \frac{L}{24 \cdot V} - F_0 \cdot \frac{L}{24 \cdot V_0} = \frac{L}{24 \cdot V_0} \left( F \cdot \frac{1}{a} - F_0 \right)
\]

\[
= \frac{L}{24 \cdot V_0} \left( \frac{V}{V_0} \right)^n \left( F \cdot \frac{1}{a} - F_0 \right) = \frac{L}{24 \cdot V_0} \left( a^n F_0 \cdot \frac{1}{a} - F_0 \right)
\]

- **In port:**

\[
\Delta(\text{consumption at port}) = f \cdot t - f \cdot t_0 = f \cdot (t - t_0)
\]

Thus, the total fuel consumption decrease due to slow steaming is:

\[
\Delta(\text{fuel consumption}) = \frac{L}{24 \cdot V_0} \left( a^n - 1 \right) + f \cdot (t - t_0)
\]  \hspace{1cm} (1)

As one may notice, the first addend is negative since, by definition, parameter \( a \) lies between 0 and 1 and \( L, F_0 \) and \( V_0 \) are always positive. This means that there will always be fuel savings.

### 3.4 Effect on fuel costs

The fuel cost reduction can be estimated by assuming that the price of the fuel used by the ship is known and equal to \( p \) (assumed constant during the year). Even though it is assumed a constant in our analysis, \( p \) is very much market-related, and, as such, may fluctuate widely in time, as historical experience has shown. For example, following the economic crisis of mid-2008, in June 2008, the average price in the Port of Rotterdam for LSFO (LS 380) and marine diesel oil (MDO) were 644.5 USD/tonne and 1,126.0 USD/tonne respectively. Prices then collapsed and came to as low as 193.5 USD/tonne (LSFO) and 420.0 (MDO) in December 2008. Since then, prices have been increasing. As of June 2011, prices are in the range of 650 USD/tonne for LSFO and 850 for MDO.

In any case, the assumption of a constant price causes no loss of generality, as an average price can be used. Also, as the ship will generally consume different kinds of fuels during the trip and in port assuming a unique fuel price is obviously a simplification. But this causes no loss of generality either, as an average price can be assumed for the general case.
By using equation (1), the reduction in fuel is:

\[
\Delta(\text{fuel costs}) = p \cdot \frac{L}{24\cdot V_0} F_0 \left( a^{n-1} - 1 \right) + f \cdot (t - t_0)
\]  

(2)

3.5 Effect on air emissions

To find the equivalent emissions that are produced, one has to multiply bunker consumption by an appropriate emissions factor. For CO\textsubscript{2}, the emissions factor depends only on the type of fuel used. On the other hand, the emission factor for NO\textsubscript{x} depends on the engine and for SO\textsubscript{2} the sulphur content of the fuel is of primary importance. Consequently, to estimate the reduction in emissions from slow steaming, the bunker consumption has to be multiplied by the appropriate emissions factor (F) that will be presented below.

Thus, by using equation (1), the reduction in air emissions is:

\[
\Delta(\text{emissions}) = F \cdot \frac{L}{24\cdot V_0} F_0 \left( a^{n-1} - 1 \right) + f \cdot (t - t_0)
\]  

(3)

Note that since the change in fuel consumption is always negative (see previous section) there is always a reduction in fuel emissions, given that the time in port is not increased.

3.5.1 Carbon dioxide (CO\textsubscript{2}) emissions

The emissions factor for CO\textsubscript{2} depends on type of fuel used. In the early literature, however, an empirical emission factor of 3.17 factor that was not fuel-dependant has been extensively used. Lately, in most reports separate emissions factors for heavy fuel oil (HFO) and for MDO are being used. For example, the 2009 IMO GHG study (Buhaug et al., 2010), which has been presented at MEPC 58, uses slightly lower coefficients, namely 3.082 for marine diesel and marine gas oils (MDO/MGO) and 3.021 for HFOs. Furthermore, in order to ensure harmonisation of the emissions factor used by parties under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol the factors presented in Table 1 can also be used.

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>GHG-WG 1/3/1</th>
<th>IPCC 2006 guidelines</th>
<th>Revised 1996 guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine diesel and marine gas oils (MDO/MGO)</td>
<td>3.082</td>
<td>3.19</td>
<td>3.01</td>
</tr>
<tr>
<td>Low sulphur fuel oils (LSFO)</td>
<td>3.075</td>
<td>3.13</td>
<td>3.00</td>
</tr>
<tr>
<td>High sulphur fuel oils (HSFO)</td>
<td>3.021</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IMO (2008b)

3.5.2 Nitrogen oxides (NO\textsubscript{x}) emissions

The NO\textsubscript{x} emissions factor mainly depends on the engine and are different for slow speed engines (SSD) and medium speed engines (MSD). Emissions of NO\textsubscript{x} are addressed in
regulation 13 of Annex VI that provides information on the so-called tier system. The tier I limit on NO\textsubscript{x} emissions applies to engines built on or after 1 January 2000. NO\textsubscript{x} emissions factors are empirical. For engines built prior to 1 January 2000, the ratio of NO\textsubscript{x} emissions to fuel consumed (tonnes per day to tonnes per day) ranges from 0.087 for SSE to 0.057 for MSE [EMEP/CORINAIR, (2002), Table 8.2]. For tier I engines, the emissions factor is 0.051 for medium speed and 0.078 for SSE (Buhaug et al., 2010).

3.5.3 Sulphur dioxide (SO\textsubscript{2}) emissions

Emissions of SO\textsubscript{x} are addressed in regulation 14 of Annex VI, which caps sulphur emissions globally at 4.50%, and less in SECAs. As regards SO\textsubscript{2}, emissions depends also on the type of fuel used. One has to multiply total bunker consumption (in tonnes per day) by the percentage of Sulphur present in the fuel (for instance, 4%, 1.5%, 0.5%, or other) and subsequently by the exact factor of 0.02 to compute SO\textsubscript{2} emissions (in tonnes per day). The factor of 0.02 is as it is derived from the chemical reaction of sulphur with oxygen.

4 Slow steaming in practice

Slow-steaming is indeed a reality. In practice, super-slow steaming has been pioneered by Maersk Line after it initiated trials involving 110 vessels beginning in 2007. Maersk Line North Asia Region CEO Tim Smith said that the trials showed it was safe to reduce the engine load to 10%, compared with the traditional policy of reducing the load to no less than 40% to 60%. 10% engine load means sailing at about half of the design speed. Furthermore, China Ocean Shipping (Group) and its partners in the CKYH alliance (K-Line, Yang Ming Marine and Hanjin Shipping) were also reported to introduce super-slow steaming on certain routes (Lloyd List, 2009).

4.1 Optimal speed

Obviously, all companies have one target: they want to make money. Tramp or liner, time charter or spot market, dry or wet there are indeed many differences. However, one thing is common: if the marker is weak (i.e., low rates) and fuel prices are high it makes sense to reduce speed. A related but often overlooked fact is that even though the owner’s and time charterer’s speed optimisation problems may seem at first glance different, for a given ship the optimal speed (and hence fuel consumption) is in both cases the same. In that sense, from an emissions standpoint, it makes no difference who is paying for the fuel, the owner or the time charterer (Devanney, 2010).

An owner in the spot market should operate at the speed that maximised the earnings per day, that is

\[
\underset{v}{\text{max}} \left[ \frac{sC}{D} - pF(v) - E \right]
\]  

(4)

where the first term is the gross profit (s is the spot rate (in $/ton), C is the cargo (in tons), D is the roundtrip distance, v is the sailing speed), the second term is the fuel costs (p is
the bunker price and $F(v)$ is the daily fuel consumption at the average speed $v$ and $E$ (in $$/day) is the so-called OPEX, which are the operating costs other than fuel costs mainly including crew wages, insurance, etc.

On the other hand, during a term charter the charterer (which is the ‘effective owner’) that needs to move $R$ tonnes per day pays $T$ ($$/day) as a term charter rate and tries to minimise the daily costs.

$$\min_v \left\{ s \left( R - \frac{C24v}{D} \right) + T - pF(v) \right\}$$

OPEX and the time charter rate do not depend on the speed and are sunk costs, costs that have been paid already and cannot be recovered and thus are not relevant to the optimisation problem. The one problem involves maximising an amount and the other minimising the negative of that amount; therefore the problems faced by the owner and the term charterer are essentially the same (Devanney, 2010).

In general, other costs (like canal fees and port dues) are also involved. There is also a difference between the person that bears these costs. Under spot charters, the owner pays the voyage expenses such as port, canal and fuel costs and under period time charters, the charterer pays these voyage expenses. Furthermore, as discussed in the previous section there is a difference in fuel consumption to achieve the same speed in laden and ballast condition. The optimisation problem may look more complicated but essentially the most crucial part is that of fuel consumption. Bunker costs are indeed the biggest portion of total non-fixed costs and that is the reason why slow steaming has attract that much attention lately.

### 4.2 BIMCO’s slow steaming clause

Under a time charter contract, the owner warrants the vessel will perform within the parameters specified, in general, under the ‘Description’ clause that states a warranted speed and fuel consumption and for clarity this normally refers to good weather conditions (specific weather and sea conditions). Any failure may cause a ‘breach of contract’ and may result in claims for damages by the charterer. Although the sector of the shipping industry that is primarily involved in slow steaming is the liner container industry, the BIMCO is trying to develop a ‘slow steaming clause’ for shipping contracts that can be used in the dry cargo and tanker trades. A BIMCO’s special working group responsible for creating standard clauses for the industry has begun a study into the development of a new slow steaming clause for voyage and time charter parties also taking a proactive approach to environmental concerns about GHG emissions. According to BIMCO the clause will also reflect the fact that there maybe commercial reasons for slow steaming such as bunker reduction and increasing demand for tonnage.

Careful consideration will also be given to underlying contractual obligations such as utmost dispatch as well as taking into account the vessel’s safety, navigation and commercial purpose related to the service speed – i.e., obligations to bill of lading holders and the need, in some circumstances, to increase the speed of the vessel (for example, owners to meet a cancelling date or charterers to respond to a just-in-time policy).

The expert group has also addressed the legal issues of slow steaming in terms of how an instruction under a time charter contract might be dealt with. According to BIMCO
(2011) the group has concluded work on a time charter version of the clause which will be put forward for adoption by the Documentary Committee in June 2011. BIMCO is now trying to deal with voyage charter parties which is more challenging than time charter due to more complex legal issues. The Clause will also take into consideration the concept of ‘virtual arrival’ that will be presented next in order to consider the impact of slow steaming on future employment of the vessel on a ‘not be unreasonably withheld’ basis. In the case that the charterers request a slower sailing speed, the expert group discusses the relevant compensation mechanism based on a percentage of the demurrage rate. What was discussed above regarding the use of weather routing companies may be also be used in this issue. In any case, BIMCO hopes that a first draft of a clause for voyage charter parties will be presented in June 2011.

4.3 Virtual arrival

Another initiative, the so-called ‘virtual arrival’ has been employed by tankers in order to manage the vessels’ arrival time based on the experience of delays at some discharging ports. Note that another possible way to minimise disruption and maximise efficiency is the prompt berthing of vessels upon arrival, a scheme that is referred to as ‘booking by rendezvous’ (Kontovas and Psaraftis, 2010).

At MEPC 60, the Oil Companies International Marine Forum (OCIMF) and Intertanko introduced their ‘virtual arrival’ project. The project recognises known inefficiencies in the supply chain, such as waiting to discharge because of port delays and reduces fuel consumption and, consequently, emissions by implementing a mutually-agreed reduction in a vessel’s speed in order to achieve an agreed arrival time at a port. This scheme in order to work needs mutually agreement by both the owner and charterer to agree a speed to meet the terminal booking that maximises fuel efficiency and minimises port waiting time. To ensure the accuracy and independence of the calculations and to avoid the risk of disputes it is proposed to use a weather routing analysis company. After the agreement of both parties the ship slows to the economical speed based on the revised arrival time. Once the voyage is completed, demurrage is calculated based on the original plans and bunker savings are split between the parties.

In a trial voyage, in 2009, Maersk’s 37,000-dwt tanker Bro Elizabeth sailed from Batumi in the Black Sea to the Isle of Grain in the UK. The voyage took 14 days in total to meet the prearranged discharge slot. The weather-routing company that was used to provide the routing also calculated the bunker savings as compared with its ‘virtual arrival’ if it had sailed at full speed to the destination. It was reported that the delay of two days saved 58.83 metric tonnes (and 183.2 mt of CO₂), a 27% reduction. In that case the demurrage was 18,000 USD and the bunker savings reached 24,800 USD (and split into half between BP and Maersk). In total the owner improved the TCE earnings by 6% and the charterer saved 3% of the total freight bill. Regarding emissions, 183.2 mts CO₂, 4.39 mts NOₓ, and 3.49 mts SOₓ were saved (Maersk Tankers, 2010).

Note that this system could also work for bulkers, who have operated at full speed to arrive at ports as early as possible only to be faced with up to a two-week wait before they can load, see for example the case of Newcastle Port. In addition, such schemes can also have safety implications. As long as the agreed speed has no implications on the safety of the vessel, this kind of initiatives can have positive effects on port congestion. This means that there is also a positive effect on safety since congestion increases the probability of accidents. For example, in 2007, a newly build 76,700-dwt bulk carrier, the
Pasha Bulker, was washed up on Nobby’s Beach by a storm as it waited to load a cargo at Newcastle Port in Australia. Therefore, reducing the waiting time outside the port also has a safety benefit given levels of congestion and the history of recent incidents in or close to busy ports.

5 Conclusions

By definition all companies carry on a business for gain. Therefore, increasing fuel efficiency in order to minimise bunker costs, which is the biggest portion of voyage costs, is the major aim of every shipping company. One of the easiest measures and probably the most economical operational measure is slow steaming. Although the sector of the shipping industry that was primarily involved in slow steaming during the recession was the liner container industry, the BIMCO is trying to develop a ‘slow steaming clause’ for shipping contracts that can be used in the dry cargo and tanker trades as it was described in Section 4.2.

Furthermore, companies are willing to adopt initiatives that sound logical and deal with practical obstacles for example port congestion. By reducing speed and arriving at port in a given time window instead of arriving early and then having to wait to be served, a ship may reduce operational cost, and, simultaneously, avoid a substantial amount of emissions. The so-called ‘booking by rendezvous’ policy in which a company could book a berthing time slot in advance and guaranteed service in that slot was investigated by the authors in a previous work (Kontovas and Psaraftis, 2010). In Section 4.3 a similar initiative, the ‘virtual arrival’, has been employed by tankers in order to manage the vessels’ arrival time based on the experience of delays at some discharging ports.

In addition, air pollution from ships has been at the centre stage of discussion by the world shipping community at least during the last decade. Shipping has thus far escaped being included in the Kyoto global emissions reduction target for CO₂ and other GHGs. But it is clear that the time of non-regulation is rapidly approaching its end, and measures to curb future CO₂ growth are being sought with a high sense of urgency. The experience gained from slow steaming due to the last economic recession will be a valuable guide for companies seeking an easy way to curb emissions.

Since fuel costs and emissions are directly proportional to one another, it would appear that reducing both would be a straightforward way towards an environmental ‘win-win’ solution. In an operational setting, one of the obvious tools for such a speed reduction: sail slower, and you reduce both emissions and your fuel bill. Therefore, lessons learned from slow steaming during the recession will be valuable in the future in the quest of curbing emissions and saving bunker cost.

References


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IMO (2008b) *Liaison with the Secretariats of UNFCCC and IPCC Concerning the Carbon to CO₂ Conversion Factor*, MEPC 58/4/3.


