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On reconciling macro and micro energy transport forecasts for strategic decision making in the tanker industry

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ABSTRACT

We propose the use of hierarchical structures for forecasting freight earnings. Hierarchical time series approaches are applied in the dry-bulk and tanker markets to identify the most suitable strategy for forecasting freight rates. We argue that decision making for shipping practitioners should be based on forecasts of freight earnings at different hierarchical levels. In other words, different strategic shipping decisions such as operations management, choice of freight charter contract and type of investment should be matched with the appropriate level of forecasts of freight earnings that are aggregated at different macro-levels: operating route, vessel size and type of trade.

1. Introduction

It is well known that the dynamics of freight revenues differ across the various segments of the shipping market, depending on the market sector, the size of the vessel as well as the underlying trading route at which each vessel operates. Hitherto, empirical work in terms of modeling and forecasting freight rates has focused on a specific level of the market thus ignoring whether the structure and hierarchy within the market have an impact in forecasting and modeling freight rates.

In many applications, one may find time series that are hierarchically organized and can be aggregated in groups based on their features. In shipping markets, we can find many instances of similar “hierarchical time series” that can be aggregated at different levels according to market sector (dry bulk or tanker), market segment across the same sector (e.g. Very Large Crude Carriers (VLCC) of 260,000 metric tonnes dead-weight (mt dwt) versus Suezmax tanker vessels of 125,000 mt dwt) as well as in terms of geographical criteria according to the underlying trade routes (e.g. East-bound or West-bound VLCC routes from Middle-East Gulf). Typically, the approach that the market has adopted is to model and forecast the series either by considering each of the time series in isolation or by examining its interactions with other variables at the same level of hierarchy.

Hierarchical time series are commonly analyzed using either a “top-down” or a “bottom-up” method, or a combination of the two. The top-down method entails forecasting the completely aggregated series, and then disaggregating the forecasts based on historical proportions. The bottom-up method involves forecasting each of the disaggregated series at the lowest level of the hierarchy, and then using simple aggregation to obtain forecasts at higher levels of the hierarchy. In practice, many businesses combine these methods, in what is sometimes called the “middle-out” method, where forecasts are obtained for each series at an intermediate level of the hierarchy, and then aggregation is used to obtain forecasts at higher levels and disaggregation is used to obtain forecasts at lower levels.

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Similar approaches should also be helpful for stakeholders in the shipping industry (shipowners, charterers, brokers, investors) who are faced with challenging strategic decisions that require valuing and assessing shipping revenues at different levels. On the one hand, decisions at the micro-operational level refer mainly to the choice of trading routes, type of contract to use (i.e. period time-charter contract or spot voyage contract), bunker arrangements and steaming speeds. Typically, such decisions are captured by the lower level of a hierarchical structure. On the other hand, decisions at the macro-investment level refer to which segment and sector of the market to operate and are typically more macro-based. Ideally, market participants should generate forecasts across all possible freight routes at which each vessel operates, but also across each vessel type and even market sector in order to decide how to deploy their fleet but also how to invest their capital.

Hitherto, the maritime economic literature that investigates freight dynamics has mainly focused on comparing forecasting methodologies for freight revenues and not on discussing forecasting strategies, as if, the generated forecasts for freight revenues at any hierarchy level are appropriate for making investment and operational decisions alike. The focus of the current literature is the accuracy of freight revenues forecasts across different methodologies and not at different aggregation levels. For instance, most studies consider the series across each tier, either on an individual basis using univariate models as in Cullinane (1992) or multi-variate models as in Kavussanos and Nomikos (2003). However, none of these studies considers the inherent correlation structure of the hierarchy in freight revenues. This research explores, for the first time, how reconciliation of revenues forecasts produced at different levels can improve forecast accuracy and hence decision making in the shipping transportation sector. This may benefit shipping practitioners in making more informed decisions, as a direct result of reconciled forecasts that consider information at various levels of the hierarchy. This is important since the various components of the hierarchy can interact in varying and complex ways. A change in one series at one level, can have a consequential impact on other series at the same level, as well as series at higher and lower levels. By modeling the entire hierarchy of a time series simultaneously, we can obtain better forecasts of the component series simply because such complex interactions can be accounted for.

The remainder of the paper is organized as follows. Section 2 provides a background review of the literature on shipping freight rate dynamics and forecasting. Section 3 describes the data and presents the empirical methodology used in the paper. Section 4 presents the empirical results and some practical examples on how the proposed methodology can be used in practice. Finally, Section 5 concludes.

2. Literature review

The main focus of the existing freight modeling literature is on investigating the dynamics of spot freight rates Cullinane (1992), or between spot and forward freight rates (see studies by Kavussanos and Nomikos (1999, 2003)), Batchelor et al. (2007) and Zhang et al. (2014)). The consensus from these studies is that univariate models are useful tools for forecasting individual freight rate series while, when one combines spot and forward rates a Vector Autoregressive (VAR) or a Vector Error Correction Model (VECM) may be preferred. In addition, the majority of studies (see Table 1) that investigate freight dynamics using spot, Forward Freight Agreements (FFAs) and Time-Charter time series, actually model freight rates across the same level of hierarchy. For example, studies by Cullinane (1992),Kavussanos and Nomikos (2003), Batchelor et al. (2007),Zhang et al. (2014) focus on one particular level of hierarchy, while studies by Kavussanos and Dimitrakopoulos (2011) and Abouarghoub et al. (2014) focus on more than one level but these studies are rather limited in their scope and do not consider all possible levels of hierarchy. In addition, none of these studies use forecasting at different levels of hierarchy for strategic decisions.

It seems therefore that the focus in the literature has been in comparing different forecasting methodologies to improve accuracy rather than looking at forecasting strategies for different hierarchy levels. The motivation for the use of hierarchical models is as follows: Shipping transport is a non-storable service that is provided by a capital intensive industry where short and long-term revenues are not linked through an arbitrage relationship (Kavussanos and Nomikos, 1999). Freight revenues are highly volatile (Alizadeh and Nomikos, 2009), seasonal (Kavussanos and Alizadeh, 2001), sensitive to energy prices and market sentiment (Papapostolou et al., 2014) and are considered to be mean-reverting in the long-run and subject to demand and supply imbalances in the short-run. For instance, Adland and Cullinane (2006) show that freight rates are non-stationary over short periods of time, yet are mean reverting over longer periods, as implied by maritime economic theory. This finding is consistent with the view that associates the dependency of conditional freight revenues to different regimes in the market (Abouarghoub et al., 2014). In addition, shipping

Table 1
Key references to hierarchical mapping in maritime literature.

Focus of the Study	Freight Market			Hierarchy-Level		
	Spot	Forward	TC	Trade	Size	Route
Cullinane (1992)	✓				✓	
Kavussanos and Nomikos (2003)	✓	✓				✓
Batchelor et al. (2007)	✓	✓				✓
Kavussanos and Dimitrakopoulos (2011)	✓			✓		✓
Zhang et al. (2014)	✓	✓				✓
Abouarghoub et al. (2014)	✓		✓	✓		✓
This Study	✓		✓	✓	✓	✓