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Portfolio optimization and index tracking for the shipping stock and freight markets using evolutionary algorithms

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ABSTRACT

This paper reproduces the performance of an international market capitalization shipping stock index and two physical shipping indexes by investing only in US stock portfolios. The index-tracking problem is addressed using the differential evolution algorithm and the genetic algorithm. Portfolios are constructed by a subset of stocks picked from the shipping or the Dow Jones Composite Average indexes. To test the performance of the heuristics, three different trading scenarios are examined: annually, quarterly and monthly rebalancing, accounting for transaction costs where necessary. Competing portfolios are also assessed through predictive ability tests. Overall, the proposed investment strategies carry less risk compared to the tracked benchmark indexes while providing investors the opportunity to efficiently replicate the performance of both the stock and physical shipping indexes in the most cost-effective way.

1. Introduction

Shipping stocks and the shipping industry should be more closely followed by investors for a number of different reasons. Among them are the underlying economic fundamentals of the shipping industry. Global shipping and the price that industrial companies are willing to pay to transport goods across the world are good indicators of the supply and demand for international trade. As the demand for international trade is directly linked to economic growth around the world (Kavussanos and Alizadeh, 2002; Stopford, 2009), shipping is often used as an economic indicator (Killian, 2009). Second, the massive wave of shipping initial public offerings (IPOs) at the beginning of the second millennium resulted in the shipping industry gaining a higher profile in the global investment stage. Such exposure has made shipping companies a target of private equity and big institutional interest, and this is well documented by the institutional ownership in shipping stocks.[1] Furthermore, over the past years, the increase in the number of analysts covering shipping stocks may be another indication that shipping stocks and the shipping industry are increasingly regarded by investors as a mainstream investment opportunity rather than a niche sector for just a few specialized investors (Grammenos and Papapostolou, 2012).

The aforementioned issues provide the incentive of this paper to devise a sound investment strategy involving shipping stocks, by addressing the index tracking problem for both stock and physical shipping indexes. To this end, we apply two popular evolutionary algorithms, namely the differential evolution (DE) algorithm developed by Storn and Price (1995) and a genetic algorithm (GA; Holland, 1975) to address the index tracking problem in the global shipping equity markets,

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[1] For instance, as of March 2010, Overseas Shipholding Group had 387 institutional investors with their share in the company accounting for 88.82%. Other notable examples are Genco Shipping & Trading, Alexander & Baldwin Inc. and Horizon Lines Inc. where the holdings of institutional investors were 85.05%, 76.42% and 90.90%, respectively (Source: Thomson Reuters).

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as represented by a market-capitalization shipping index, constructed by 95 shipping stocks listed on 19 stock exchanges. Our approach gives the option to US investors, who have limited access to any of the stocks comprising the shipping index, to invest in a portfolio that closely replicates its performance, has no exchange rate risk and includes only a small pre-specified number of stocks. In particular, the performance of the index is reproduced by investing in US shipping stocks.

To our knowledge, the current literature is mainly concentrated on the index tracking problem with respect to equity indexes. This paper is the first to attempt to track the performance of the physical shipping market, as represented by the Baltic Dry Index (BDI) and the Baltic Dirty Tanker Index (BDTI). This has important practical implications for investors who want to participate in the physical shipping market but often find themselves with limited investment options, as in the case of pension funds. The two physical indexes are provided by the Baltic Exchange, while the International Maritime Exchange (IMAREX) and investment banks also offer futures contracts on these indexes. However, access to these products is limited with potential frictions for investors. Investing in futures contracts entails higher risk due to the highly volatile nature of the physical shipping markets, expiration effects and the high monthly rollover cost, which is necessary to maintain a long-only position on the index.

In particular, nearby contracts must be sold and contracts with later deliveries must be purchased. This process is referred to as ''rolling'', and irrespectively of whether the futures curve is in backwardation or contango, investors need to actively trade and accept the market prices for both transactions, i.e. the liquidation of the current-month contract and the purchase of the next-month contract. As a result, the frequent rolling-forward makes it very expensive to follow an index replication strategy using exchange-traded futures. Moreover, shipping futures contracts expire less frequently compared to financial contracts, thus rolling forward can be more costly and vulnerable to longer duration and thinner liquidity. Finally, long-only futures indexes offer little protection against any abrupt price changes, as they do not provide the possibility of short-selling, and most of them are rebalanced only once a year.

Two additional unique aspects of this paper involve the analysis of different rebalancing settings on the performance of the tracking portfolios, as well as the consideration of the data snooping bias. A sound rebalancing framework is essential to ensure that the portfolio maintains the optimal relative allocation over time, given that, if correlations of the assets comprising the tracking portfolio are time-varying, the structure of the fund must adjust to accurately reflect the benchmark index. Moreover, rebalancing deals with potential weight instability due to, for example, structural changes in the fluctuations of prices. The aim is to provide investors and financial institutions with valuable information on whether regular revision of the portfolio formation is able to exploit the arrival of news. This issue is examined empirically in this study, while at the same time evaluating how much transaction costs affect performance. Besides contrasting rebalancing strategies to replicate the considered equity and physical shipping indexes, it is also interesting to identify which subset of the stocks is more likely to effectively mimic each respective benchmark index. Thus, tracking ability is tested while controlling for data snooping. The latter is achieved by applying Hansen's (2005) superior predictive ability test to examine whether the best performer is indeed superior compared to the competing subsets of stocks. The goal is to determine the statistical significance of the empirical findings in three aspects, namely the efficiency of the algorithms employed, the performance of the index tracking strategies and the implemented rebalancing schemes.

In terms of investment opportunities, the shipping industry can offer investors a number of choices. These may range from debt and derivative related instruments (Grammenos et al., 2008; Kavussanos and Visvikis, 2006) to equity investments in publicly listed shipping companies and shipping-specific funds (Syriopoulos and Roumpis, 2009; Drobetz et al., 2010; Merikas et al., 2010; Drobetz and Tegtmeier, 2011). The investment strategies proposed in this paper give investors the opportunity to replicate the performance of both stock and physical shipping markets by investing in easily accessible stocks. Investors may also take short positions when they believe that the maritime sector is entering a downturn. Additionally, fund managers can benefit from the proposed strategies when they overweight or underweight specific sectors according to their market and economic outlook. Risk-averse investors who wish to track the performance of the highly volatile maritime industry can also invest in the proposed portfolios that carry lower volatility. Finally, there is a plethora of mutual funds and Exchange Traded Funds (ETFs) that track passive benchmarks of stock, commodity, business sector, country, regional indexes, etc. The results of the paper could encourage mutual and hedge fund managers to recognize the importance of the maritime sector and set up similar funds[2] that will track the proposed shipping equity and physical indexes. To that end, our methodology puts forward an effective and at the same time cost-effective way to operate such a fund.

The structure of the paper is as follows. Section 2 presents a literature review on index tracking methodologies for passive investment strategies, together with a description of the problem formulation, the solution algorithms and the superior predictive ability test methodology. Section 3 gives an explanation of the data and the construction of the market capitalization shipping index. In Section 4, the empirical results are discussed. Finally, Section 5 concludes the paper.

2. Index tracking for passive investment strategies

Financial portfolio management is implemented by using active or passive strategies.[3] On the one hand, under the active strategy, portfolio managers assume that markets are not perfectly efficient and that there is room for exploiting any

[2] A shipping ETF can be used by ship owners or other market participants of the maritime and transportation industry, to complete parts of their existing portfolios or to perform tactical investment strategies.

[3] For a comparison between active and passive strategies see Sharpe (1991), Malkiel (1995), Sorenson et al. (1998), Barber and Odean (2000), Frino and Gallagher (2001), Beasley et al. (2003), Konno and Hatagi (2005), Maringer and Oyewumi (2007).