Ship funds as a new asset class: An empirical analysis of the relationship between spot and forward prices in freight markets

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Risk management in shipping

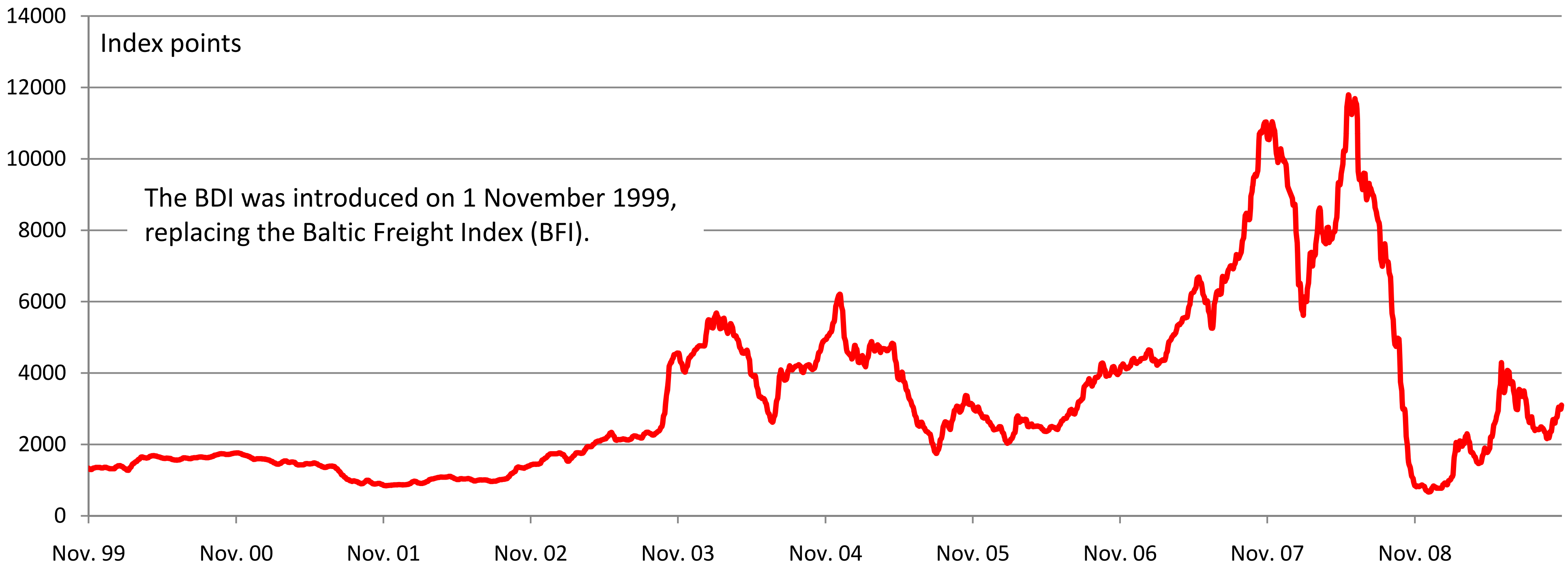
- The significance of risk management in the freight market has been recognized among the participants in the shipping industry for a long time, as indicated by the development of **physical hedging** methods, e.g., period-time charter contracts and contracts of affreightment.
- It was not until the early 1980s when shipowners, charterers and other parties involved in shipping realized that risk-management techniques which had been applied successfully in commodity and financial markets (such as hedging using futures, forwards, swaps and options) could also be developed and applied for risk management in the shipping industry.
- In order to trade derivatives on freight (**paper hedging**), a necessary condition is the availability of reliable price information on the underlying freight market, based on which derivatives can be priced and settled.
  - The Baltic Exchange is the leading provider of freight-market information, and most derivative transactions in the dry and wet markets are settled against these indices.

Baltic Capesize Index (BCI)

Route	Cargo type and size	Route description	Weighting
C2	160,000 mt iron ore	Tubarao to Rotterdam	10%
C3	160,000 mt iron ore	Tubarao to Qingdao	15%
C4	150,000 mt coal	Richards Bay to Rotterdam	5%
C5	160,000 mt iron ore	W. Australia to Qingdao	15%
C7	150,000 mt coal	Bolivar to Rotterdam	5%
C8_03	172,000 mt dwt	Delivery Gibraltar-Hamburg range for a trans Atlantic round voyage, redelivery Gibraltar-Hamburg range. Duration: 30-45 days	10%
C9_03	172,000 mt dwt	Delivery Amsterdam-Rotterdam-Antwerp range for a trip to the Far East, redelivery China-Japan range. Duration: 65 days	5%
C10_03	172,000 mt dwt	Delivery China-Japan range for a Pacific round voyage, redelivery China-Japan range. Duration: 30-45 days	20%

Baltic Dry Index (BDI)

- The Baltic Dry Index (BDI) is a composite index calculated as the equally weighted average of the BCI, BPI, BHSI and BHI.
- It is widely viewed by practitioners as a **general market indicator** reflecting the movements of the dry-bulk market.



Source: Baltic Exchange, 2010

What is a forward freight agreement? (1)

- A **forward freight agreement (FFA)** is an agreement between two counterparties to settle a freight rate or hire rate, for a specified quantity of cargo or type of vessel, for one or a basket of the major shipping routes in the dry-bulk or the tanker markets at a certain date in the future.
- The underlying asset of FFA contracts is a freight rate assessment for the underlying shipping route or basket of routes, which is produced by the Baltic Exchange or by other providers of market information.
- FFAs are **settled in cash** on the difference between the contract price and the settlement price, and there is **no physical shipment** involved.
- The calculation of the **settlement price** differs with the type of the contract:
  - Settlement rate as the average freight rate of the month applies for most contracts.
  - Settlement rate as the average freight rate of the last seven trading days applies for certain contracts (such as P2A and P3A).

What is a forward freight agreement? (2)

- An average settlement rate is used to ensure that settlement rates are not susceptible to large moves due to high volatility or market manipulation.
- FFA trades concentrate on certain routes:
  - In the **Capesize market** most trades are on the BCI C4 and BCI C7 routes and on the average of the four trip-charters of the BCI (BCI 4TC).
  - In the **Panamax market** most trades are on the average of the four trip-charter routes of the BPI (BPI 4TC); there is also some liquidity on the BPI P2A and the BPI P3A routes.
  - The basket trip-charter routes are used to hedge the average monthly trip-charter earnings. These trip-charter routes cover the major trading patterns on which dry-bulk carriers operate, and hence the average of these routes reflects the average earnings of those vessels.
  - On the **dirty market** most trades are on routes TD3, TD5, and TD7, and on the **clean market** trades concentrate on routes TC2, TC4, and TC5.

Hedging using FFAs: The basic principles

- A "**short**" or **"selling" hedge** involves selling FFAs as a protection against an unexpected decline in freight rates.
  - Typically, **shipowners** (ship operators) who want to **protect their freight income** are sellers of FFAs. If the freight rates falls, the reduction in freight income will be compensated through a gain in the forward position.
- A "**long**" or **"buying" hedge** involves buying FFAs as a protection against an unexpected price increase.
  - Typically, **charterers** are buyers of FFAs; this enables them to **protect their forward freight requirements** in case the physical market increases, which would in thus force them to pay higher freight rates.

Differences between forward and futures contracts

	Futures	Forwards
Trading	Exchange-traded	Over-the-counter (OTC)
Credit risk	Guaranteed by clearing house	Counter-party risk (OTC clearing also possible)
Deposits/Collateral	Initial margin deposit	Usually not required
P&L	P&L realized daily through marking-to-market	P&L realized at the settlement of the contract
Contract terms	Highly standardized	Tailor-made
Closing position	Usually by closing contracts on the exchange before maturity; offset or reversing trade	Negotiated between the counter-parties or via offsetting trade; but usually carried until maturity

Source: Alizadeh and Nomikos (2009)

The term-structure in the forward markets (1)

- Market participants can buy (sell) their future demand (supply) today in order to fix the price and receive reliable cash flows.
- The **price discovery** in the forward markets sends signals to the marginal producers and consumers of a product in order to increase or reduce production or consumption, respectively.
- Across time, spot prices and forward prices are mutually linked by the **cost-of-carry relationship**.
  - If the forward price of a good is higher than the current spot price plus the cost of storing the good until the forward's maturity, then market participants could earn a risk-free ("arbitrage") profit from selling forward and buying spot simultaneously.
  - These trades will realign the spot prices and the forward prices.
- However, this is not true for the freight markets, as the good **"freight" is non-storable**, i.e., it cannot be stored or carried forward in time.

The term-structure in the forward markets (2)

- The prices of Forward Freight Agreements (FFAs) are not linked by a cost-of-carry relationship to the spot freight rates. FFA prices for different time periods are not linked as well.

- This leads to unique empirical properties of freight rates:
  - Even if one is sure that tomorrow the time charter rate of a Panamax vessel will be 500 US$ higher than today, one cannot profit from this knowledge because transportation capacity cannot be bought today and sold tomorrow at a higher price.
  - Patterns, such as **autocorrelation** and **seasonality**, can well persist in spot prices.
  - In efficient markets and in the absence of a risk premium, forwards rates will be an **unbiased predictor** of future spot prices. The forward price is the market-expected spot price in markets for nonstorable commodities, i.e., the anticipated demand and supply will be reflected in forward prices.

- If forward rates are an unbiased predictor for future spot rates, then **spot rates must converge towards forward rates** as maturity approaches.

Cointegration in the freight markets (1)

- Two time series with a long-term equilibrium to which they converge will exhibit a **cointegration relationship**.
  - If forward rates are an unbiased predictor of future spot rates, the “co-integration vector” should be (1, –1).
  - This is equivalent to the assertion that there is an **equilibrium if forward rates equal spot rates.**

- We investigate this hypothesis using a sample of daily spot and FFA prices from October 2004 to April 2007 published by the Baltic Exchange. The data includes different maturities (i.e., one to three quarters ahead, one year ahead, and two years ahead). We test for the unbiased hypothesis for all maturities.

- Our results indicate that the **bias in the prediction seems to increase with maturity.** A possible explanation for this bias is the existence of a risk premium for future contracts which makes the FFAs to quote at a discount to the risk-neutral expectation of the future spot rates.

Cointegration in the freight markets (2)

- The **unbiasedness** of the prediction is **rejected** at a confidence level of 90% for all maturities and even of 99% for the front quarter.
- However, for the **short maturities** the estimated cointegration vector is close to the theoretical (1, –1) vector expected for an **unbiased predictor.**

Regressor	Cointegration vector of spot and forward freight rates				
	+1Q	+2Q	+3Q	+1A	+2A
	$\ln(S_{t-1})$	$\ln(S_{t-1})$	$\ln(S_{t-1})$	$\ln(S_{t-1})$	$\ln(S_{t-1})$
C	−0.044	−0.635	−0.823	−0.792	−4.24
	(−0.28)	(−3.68)	(−3.52)	(−3.34)	(−11.8)
$\ln(F_{t-1})$	1.007	1.074	1.099	1.103	1.483
	(65.27)	(62.35)	(46.70)	(46.15)	(40.23)
Adj. R^2	0.873	0.867	0.807	0.772	0.720
ADF p-value	0.002	0.005	0.061	0.058	0.043
ADF p-value with (1, −1)	0.002	0.014	0.066	0.063	0.067

This table shows the cointegration relationship between spot and forward freight rates. The numbers in brackets indicate the t-values of the estimated coefficients. The one-sided p-values are from an augmented Dickey–Fuller (ADF) test for a unit root in the residuals. The lag length is chosen following the Akaike Information Criterion. The last line provides the p-values based on the theoretical cointegration vector of (1, −1).

Cointegration in the freight markets (3)

- The spread between spot and forward rates (the "basis") has to narrow as maturity approaches. Intuitively, we expect the necessary **adjustment for a given spread to be stronger for shorter maturities**.

- If we expect the future spot rate S(M) to equal the current forward rate F(t) at maturity M, then we should see an average speed of adjustment V of:

$$V = \frac{F(t) - S(M)}{M}$$

- Accordingly, we take the remaining time to maturity into account when estimating the expected impact of the deviations from equilibrium (i.e., F=S) on changes of the forward rate F and the spot rate S.

Cointegration in the freight markets: VEC regression results

	VAR		VEC		Adj. VEC	
	ΔS_t	ΔF_t	ΔS_t	ΔF_t	ΔS_t	ΔF_t
Spot rate and forward freight rate for 1st front quarter (+1Q)						
ΔS_{t-1}	0.933	0.058	0.920	0.054	0.917	0.052
	(19.81)	(0.38)	(19.63)	(0.36)	(19.58)	(0.34)
ΔS_{t-2}	−0.215	−0.166	−0.209	−0.164	−0.207	−0.163
	(−5.26)	(−1.27)	(−5.14)	(−1.26)	(−5.11)	(−1.25)
ΔF_{t-1}	0.169	0.307	0.162	0.305	0.161	0.304
	(11.19)	(6.39)	(10.71)	(6.28)	(10.71)	(6.27)
ΔF_{t-2}	0.021	−0.012	0.017	−0.013	0.017	−0.013
	(1.36)	(−0.23)	(1.09)	(−0.26)	(1.09)	(−0.26)
Z			−0.009	−0.003		
			(−3.17)	(−0.30)		
$Z/\sqrt{\Delta t}$					−0.116	−0.042
					(−3.42)	(−0.38)
Adj. R^2	0.823	0.100	0.826	0.099	0.827	0.099

This table shows the results of various VAR and VEC models for spot and forward freight rates. The deviation from the cointegration relationship, Z, is restricted to the basis, $S_{t-1} - F_{t-1}$. $Z/\sqrt{t}$ denotes the adjusted deviation, as defined in Equation (5) in the text. The values in brackets indicate the t-values of the estimated coefficients.

Cointegration in the freight markets: Main findings

- Most of the daily changes in **spot rates** are explained by **autocorrelation** and by changes in the forward rates.
- Changes in forward rates are not explained by past changes in spot rates. There is, however, a highly significant autocorrelation in forward rates that is difficult to conciliate with efficient markets.
- The coefficient on the deviation from the equilibrium Z is significant for spot rates but not for forward rates. We conclude that **spot rates tend to converge to forward rates** in case of deviations from equilibrium, and not vice versa.
- The error correction coefficient is small in magnitude. The influence is **negligible on a daily basis, but not for longer horizons**. The influence is stronger than that from autocorrelation on a time scale of more than ten days.
- Scaling the deviation with the square root of the remaining time to maturity increases the significance of the error correction coefficient. As expected, the coefficients for different maturities become comparable in size.