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THE ECONOMICS OF HEDGING DRY BULK OCEAN FREIGHT USING THE BALTIC INTERNATIONAL FREIGHT FUTURES EXCHANGE

by Greg S. Condas & James W. Dunn***

ABSTRACT

This paper examines the hedging properties of the ocean freight futures contracts. This involves measuring the possibilities for risk reduction using the contract in various ways and the cost of this risk reduction. Freight futures reduce price risk more with longer hedges. Although hedging over a shorter interval works in theory, it actually does not help reduce risk. They are best suited for hedging on the routes that have large weights in the Baltic Freight Index, especially grain movements. Market volume on the exchange can be low, which may make hedging large shipments difficult.

Dry bulk ocean shipping moves over one billion tons of raw materials annually. The major commodities moved are grains, iron-ore, coal, bauxite, alumina, phosphate rock, and ferrous scrap metal. These commodities all have low value per ton, making shipping costs an important portion of the delivered price. The dry bulk shipping market is virtually unregulated and can be volatile. Prices can be influenced by world events, including changes in the supply or demand for bulk products, natural disasters, terrorist threats, and the world's political climate. Slim profit margins in the grain and ore industries make charterers vulnerable to unforeseen changes in freight rates. In response to a perceived need for protection from volatility in these rates, freight futures contracts began trading on the Baltic International Freight Futures Exchange (BIFFEX) in London on May 1, 1985.

Ocean-freight futures are the first futures contract designed for a service. Unlike traditional futures contracts no physical good backs the contract. The service is represented by the Baltic Freight Index (BFI), a bundle of shipping services that is a proxy for the world freight price. A panel of Baltic Exchange member cash market brokers provide daily price quotes for 12 major dry bulk trade movements. Each member submits a spot rate he considers representative for each route. Since all routes

do not have daily transactions, the bid represents the broker's best estimate of what the spot price of a ship contracted on the given day would be. Panel members are unaware of each other's bids and the final bids are randomly assembled by a computer. The bids are then averaged by route and weighted to reflect a route's overall importance. The BFI is therefore an index that is supposed to accurately reflect daily economic conditions in the world spot dry-bulk carrier market.

The definitions of the component routes and their respective weights are shown in Table 1. The BFI weights total 65% for grain routes and 17.5% for coal, with the last 17.5% split between petroleum coke, iron ore, and phosphate rock. The index was initially set at 1000. Over time it has changed as conditions in the dry-bulk carrier market changed.

The BIFFEX does not trade the index but instead futures contracts whose value are determined by the index. Each futures contract values each index point at \$10, and all prices shown are in whole index points (i.e., no fractions). Contracts expire on the last business day of January, April, July, and October and are traded up to two years in advance of expiration. Since each contract represents a bundle of freight rates, delivery is not possible and all settlements are cash. The settlement price is the average of the BFI for the last five days of trading in the contract's expiration month. An open position held at contract maturity is automatically closed at the settlement price, with settlement on the next business day after the final day of trading.

Because futures markets trade uniform contracts with all specifications determined in advance, the only transaction detail needed to be determined in the marketplace is the price. As such trading is very inexpensive compared to a nonuniform forward contract where many details in addition to the price must be agreed upon by the parties involved. As long as the price in the futures market and the price in the market a person will be dealing for his future

freight shipment have a predictable relationship, a shipper could use the futures market to protect himself against adverse price movements between the time an agreement is made to ship a commodity and the time the transportation is arranged with low transactions costs. This use of the futures market is called hedging.

TABLE 1
BFI COMPONENT ROUTES

1. 1 port US Gulf/Antwerp, Rotterdam, Amsterdam ^a-[20]- \$5,000 5 % Heavy Soya Sorghum, FIO^c, 11 days, Sundays, holidays excepted, laydays 10 days forward from date of index^d, cancelling maximum 30 days forward from date of index^e, 3.75 % brokerage^f.
2. 1 port US Gulf/1 port South Japan ^a-[20]- \$2,000 5% Heavy Soya Sorghum, FIO, 11 days, Sundays, holidays excepted, laydays 10 days forward from date of index, cancelling maximum 30 days forward from date of index, 3.75% brokerage.
3. 1 port US North Pacific/1 port South Japan ^a-[15]- \$2,000 5% Heavy Soya Sorghum, FIO, 11 days, Sundays, holidays excepted, laydays 10 days forward from date of index, cancelling maximum 30 days forward from date of index, 3.75% brokerage.
4. 1 port US Gulf/Venezuela ^a-[5]- 21,000 5% Heavy Soya Sorghum 4 days/1,000, FIO, laydays 10 days forward from date of index, cancelling 25 days forward from date of index, 3.75% brokerage.
5. Antwerp/Jeddah ^a-[5]- 35,000 10% Bulk Barley, FIO, 4,000 SHEX load/3,000 FHEX discharge, laydays 10 days forward from date of index, cancelling 25 days forward from date of index, 3.75% brokerage.
6. 1 port Hampton Roads and Richards Bay/1 port South Japan ^a-[7.5]- 120,000 10% Coal, 8 days, Sundays, holidays included, 15,000 Richards Bay, laydays 10 forward from date of index, 3.75% brokerage.
7. 1 port Hampton Roads excluding Baltimore/1 port Antwerp Rotterdam Amsterdam ^a-[5]- 65,000 10% Coal, 5 days, Sundays, holidays included/Sundays, holidays excepted, laydays 10 forward from date of index, cancelling maximum 30 days forward from date of index, 3.75% brokerage.
8. Queensland/Rotterdam ^a-[5]-110,000 10% Coal, FIO 40,000, Sundays, holidays included/25,000 Sundays, holidays excluded, laydays 15 days forward from date of index, cancelling 25 days forward from date of index, 5.0% brokerage
9. Vancouver - San Diego Range/Rotterdam ^a-[5]-55,000 10% Petroleum Coke, FIO 10,000, Sundays, holidays included/10,000 Sundays, holidays excluded, laydays 15 days forward from date of index, cancelling 25 days forward from date of index, 3.75% brokerage.
10. Monrovia/Rotterdam ^a-[5]- 90,000 10% Iron Ore, 5 days Sundays, holidays included, laydays 15 days forward from date of index, cancelling maximum 30 days forward from date of index, 3.75% brokerage.
11. Casablanca/West Coast India (30FT SWAD) ^a-[2.5]-15/25,000 Phosphate Rock scale gross/1000 free, laydays 10 days forward from date of index, cancelling 25 days forward from date of index, 5.0% brokerage.
12. Aqaba/1 port West Coast India ^a-[5]- 14,000 5% Phosphate Rock, FIO 3,500/1,000, laydays 10 days forward from date of index, cancelling 25 days forward from date of index, 5% brokerage.

^a Percentage of index in brackets.

^b Heavy grain, i.e., maize, wheat, and rye.

^c Cost of loading and unloading is borne by the charterer.

^d Allows charterers a fixed number of days for loading and unloading.

^e Number of days prior to the transaction that a ship must arrive at the loading point. Charterers have the right to decline the service if the ship is late.

^f Brokerage fee.

The objective of this paper is to examine the hedging properties of the BIFFEX futures contracts. This will involve measuring the possibilities for risk reduction using the contract in various ways and the cost of this risk reduction.

HEDGING ON THE BIFFEX

Hedging is any strategy used to offset price risk. Since vessel operators are long in the physical freight market, if they sell a futures or a forward contract, they establish a hedge. The Baltic Freight Futures Exchange offers hedging opportunities for both vessel owners and charterers.

Besides freight futures, an exporter has two states after contracting for future delivery of a good. He is completely exposed to market fluxuations until it charters a ship at which point his price is fixed.¹

Freight futures contracts introduce a third state. Table 2 presents a hedging example that illustrates the possible benefits of both forward and futures contracts. In the example, the initial futures price index (1300) is at a discount to the initial spot price index (1415). This means that the market opinion is that although the index is 1415 today, by the time the contract expires it will have fallen to 1300. Such a spread might be seen in April for the July contract. In the summer, trade in bulk goods is normally sluggish.

Our shipper knows he will need space for 55,000 tons on August 1. It is now April. The price for the route he will be shipping his cargo is \$12.00 per ton if he were shipping today. Like the market in general, he is expecting a price decrease. If the decrease is proportional to the expected change in the BFI $((1300-1415)/1415$ or -8.1%), the price for his route will be \$11.02. He could delay booking a vessel until August, hoping that \$11.02 will be the price.

Suppose an unforeseen increase in price raises the spot index to 1710. This increase of 20.8% if his route changed proportionately would be \$2.50/ton which would increase his total cost by \$137,500; an expensive forecasting error. If the shipper expects freight rates to rise, he could book a ship now for August 1. A rate of \$12.00 per ton could be contracted since all other information indicates

a price decline.² The shipper could lock in the lower freight costs.

Another option is to reduce the risk of an adverse change in the freight rate for his route by being long in the futures market. Purchase of 46 Baltic Freight Contracts at 1300 per contract (recall each contract is for \$10/BFI point or \$13,000) roughly covers his freight exposure, i.e. is about the same amount of money as 55,000 tons times \$12.00/ton.

At the end of July, suppose the futures market reflects the current BFI value of 1710 and the local price has changed proportionately to \$14.50/ton. Our shipper can sell his contracts for \$17,100, or 10 times the BFI per contract and book a ship in the spot market for \$14.50. He will have made \$188,600 in the futures market, or \$3.43/ton shipped. However, the spot price will have been \$2.50/ton worse than had he contracted his ship at \$12.00 in April. Adding in \$3200 in brokerage costs makes the net freight costs to the shipper is \$11.13 per ton after transaction costs.

In addition, \$32,200 will have to be kept on deposit with the brokerage firm as security against the value of the contracts falling. Any interest on this money is lost, but is not included in this example.

The shipper is this example gained protection against having the freight rate rise while the ship remained unbooked. If he had expected to be able to book the ship at \$11.02, which was the rate implied by the price of the July contract, he did \$0.11 worse per contract than he might have expected. About half of this is brokerage fees and about half due to his position requiring 46.6 contracts to be fully covered.

Although not presented in the example, price risk still exists with the futures strategy because the route price may not be perfectly correlated with the BFI. The forward pricing method described above eliminates all price risk. In this example, however, forward contracting cost the charterer \$0.37 per ton if \$11.50 per ton is the contract price.

A ship operator or an investor in a ship can also hedge using freight futures by selling contracts and buying them back when the ship is booked. Ordinary forward contracting is also an option. The arithmetic is similar but in this case the shipper who hedged would forgo the opportunity to get \$14.50 and instead end up with about \$11.00. Since he also would pay

TABLE 2

Hypothetical Charterer Hedge^aTime: Contract Commodity

Spot: Sell cargo forward		Futures: Hedge freight rate	
BFI	1415	Futures index	1300
Freight cost (\$/ton)	12.00	Implied rate (\$/ton)	11.02
Tons to ship	55,000	Contracts bought	46
Total freight cost	(\$660,000)	Total position	(\$598,000)

Time: Ship Commodity

Spot: Fix ship		Futures: Close buy position	
BFI	1710	Futures index	1710
Freight cost (\$/ton)	14.50	Contracts sold	46
Total freight cost	(\$797,500)	Total position	(\$786,600)

Final costs, gains, and (loss)

Spot freight market	(\$2.50 / ton)
Futures market	\$3.43 / ton
Spot freight cost	\$14.50 / ton
Gross actual cost	\$11.07 / ton ^b

Inclusion of transaction costs

Transaction cost / contract	\$70
Total transaction cost	\$3,200
Net freight cost per ton	\$11.13

Margin Requirements

Margin requirement / contract	\$700
Total margin	\$32,200

^a Assumes market beta between spot and futures is 1.0, i.e., a one-point change in the index results in a one-point change in the route price.

^b This value is not \$11.02 because to fully cover the position requires buying 46.6 contracts.

brokerage costs his price would be lowered by those. The inability to sell 46.6 contracts would benefit the ship operator since he would have a bit of the ship unprotected and get a favorable price movement.

This ship operator example shows one of the disadvantages of hedging. The price received is more predictable, but prices can be unpredictably high or unpredictably low.

Margin Financing

Hedging using futures markets requires a margin deposit. In the example given, \$35,000 would be required by the clearing house to secure the transactions. In addition if the market moves far while the hedge is in place additional margin may be required. These adverse movements in the value of the contract will ideally be offset by corresponding changes in the market being hedged, but margin financing will be required nonetheless. A banker that understands the difference between hedging and speculation is essential.

SPECULATING ON THE BIFFEX

The contribution of the speculator depends primarily on the market. For precious metals and financial futures, speculators may be the most important force in the price discovery processes. Their role changes in "hedging markets". A hedging market is a market where the amount of speculation actually depends on the amount of hedging activity. Markets for many agricultural commodities and for ocean freight may be considered as hedging markets. In these markets, speculators are necessary to offset hedged positions and provide liquidity.

Working (1960) contends that commodities traded on obscure markets from which quotations are not readily available tend to get limited speculative activity. His premise is supported by the freight futures market. Initial trading volume on the BIFFEX was low. Not until the Chernobyl disaster in the spring of 1986 did speculators find the freight futures markets attractive. Because the supply of vessels adjusts slowly, speculation on the BIFFEX is synonymous with speculating on the demand for bulk shipping services, i.e., on the volume of export trade.

OPTIMAL HEDGE RATIOS

A hedger need not take equal and opposite positions in futures and cash markets. The ratio of the futures market position to the cash market position can be equal to, less than, or greater than 1.0 as an adjustment for changes in the basis brought about by quality, spatial, and temporal differences along with a range of unknown factors. The decision to hedge and how much of one's cash position to hedge comes from the expected utility function of an individual. Therefore, Johnson (1960) applied Markowitz portfolio theory to hedging. He assumes a hedger wishes to maximize his expected utility of returns. Under a set of restrictive assumptions the expected utility function is reduced to a function of expected returns and variances. The variance of returns is usually interpreted as risk and its importance in the utility function is weighted by an individual's subjective risk aversion parameter. Early studies of the optimal hedge ratio (Johnson, 1960; Ederington, 1979) normally assumed that the agent was infinitely risk averse and that the portfolio problem of futures and cash positions was reduced to choosing a futures position to minimize the variance of returns.

Although the optimal futures and cash positions are dependent on the decision maker's degree of risk aversion, Kahl (1983) showed the optimal hedging ratio does not contain the risk parameter. She derives the optimal hedge ratio to be

$$X_f/X_c = (\mu_f \sigma_c^2 - \mu_c \sigma_{fc}) / (\mu_c \sigma_f^2 - \mu_f \sigma_{fc}) \quad [1]$$

where X_f is the level of the futures position, X_c is the level of the cash position, μ_f is the expected profit from holding a long futures position, μ_c is the expected profit from holding a cash position, and the σ 's are their respective variances and the covariance. The individual's level of risk aversion affects the size of X_f and X_c but not their ratio. Therefore, if the agent chooses his position in both markets, the optimal hedge ratio is not dependent on the degree of risk aversion.

Peck (1975) argues that the minimum variance hedge ratio may not be optimal in instances where the agent cannot adjust his cash position, e.g., a farmer planting crops. If production decisions are hard to alter, mean-

variance measures of return and risk do not reflect the uncertainty actually facing producers. A producer must make a decision based on some price expectation. Having made a production decision the relevant variability of price is that which surrounds the accuracy of the producer's forecasts. One measure of this risk is the mean squared error (MSE) of the forecast.

Assuming that costs are fixed and output is non-stochastic the returns and risks for an unhedged position are written as

$$E[R] = E[X_c P_{t+i}] = X_c P_t^* \quad \text{and [2]}$$

$$\begin{aligned} \text{MSE}[R] &= E[X_c P_{t+i} - E[X_c P_{t+i}]]^2 \\ &= X_c^2 \sigma_p^2 \end{aligned} \quad \text{[3]}$$

where P_t^* is the expected price and σ_p^2 is the MSE of the cash price forecasts.

If an agent hedges his output and cash and futures prices do not converge when the futures position is offset, the expected risks-returns are expressed as

$$\begin{aligned} E[R] &= E[X_c P_{t+i} + X_f(F_t - (P_{t+i} + B_{t+i}))] \\ &= X_c P_t^* + X_f(F_t - P_t^* - B_t^*) \quad \text{and [4]} \\ \text{MSE}[R] &= E[R - E[R]]^2 \\ &= (X_c - X_f)^2 \sigma_p^2 + X_f^2 \sigma_b^2 - 2X_f(X_c - X_f)\sigma_{pb} \end{aligned} \quad \text{[5]}$$

where B_t^* is the expected basis at the close of the hedge, B_{t+i} is the actual basis defined as $(F_{t+i} - P_{t+i})$, and σ_b^2 and σ_{pb} are measures of the variance of the basis forecasts and the covariance of the cash-basis forecasts, respectively. The measures of the σ 's used here are their respective MSE's.

Kahl (1983) shows this implies the optimal hedge ratio is³

$$X_f/X_c = [\mu_f / (2\lambda\sigma_f^2 X_c)] - (\sigma_{fc} / \sigma_f^2) \quad \text{[6]}$$

A common way to estimate the optimal hedge ratio is to assume that the agent is infinitely risk averse (Johnson, 1960; Ederington, 1979). The minimum variance hedge ratio is

$$X_f/X_c = -\sigma_{fc} / \sigma_f^2 \quad \text{[7]}$$

The hedge ratio can be obtained from regression of cash prices on futures prices. The assumptions and proofs are in Benninga et al., (1984). They show that the hedge ratio in an

unbiased futures market is the slope parameter obtained from the regression⁴

$$CP_{t+i} - CP_t = \alpha + \beta(FP_{t+i} - FP_t) + \epsilon_{t+i} \quad \text{[8]}$$

Their analysis depends on the very restrictive assumption that $E_t[CP_{t+i}] = FP_t$. When using the model, because of this assumption, the researcher must be willing to concede that basis risk and a risk premium are absent from the market. Systematic basis risk is likely to occur in cross-hedging and index-hedging situations.

Bond, Thompson, and Lee (1987) adjusted the model include basis risk and a risk premium. If the relationship between the expected spot price and the futures price is assumed to be linearly related, then the expectation of the subsequent spot price is

$$E_t[CP_{t+i}] = \kappa + \delta FP_t \quad \text{[9]}$$

where if $\kappa = 0$ and $\delta = 1$, the futures price is an unbiased estimate of the spot price and the model reduces to Benninga's. Rewriting the forecast error to include [5] yields

$$CP_{t+i} - \kappa - \delta FP_t = \alpha + \beta(FP_{t+i} - FP_t) + \epsilon_{t+i} \quad \text{[10]}$$

Bond concludes that the optimal hedge ratio formula is not changed but is modified to accommodate a biased market. One advantage of this model is that it can be used for cross-hedged commodities.

Optimal Hedge Ratios in the Freight Market

The model used for estimating optimal hedge ratios in the freight market must accommodate the behavior of the shippers, the ship owners, and the market. The utility maximization problem may differ if the agent is long or short in the futures market.

For the ship owner the methodology proposed by Heifner (1973) will be used. The cash position of ship owners is not fixed. They have the option to choose among various products to haul, various routes, and laying vessels up in low-profit times for needed repairs. Unlike the corn farmer, whose options are to accept the market price for X_c units of product at harvest time, harvest and store the good, or not harvest ($X_c = 0$), the ship owner can accept the market price for a certain route, haul

different goods, change routes, or withdraw from the market for a while. Therefore, the risk aversion constant need not be considered.

Unlike the ship owner, the position of the shipper is fixed. Once an exporter signs a contract to deliver X units of goods, vessel space on a particular route is required. The shipper has no choice but to accept the market price or default on the contract. The methodology used to determine the optimal hedge ratio for the shipper must therefore adjust for risk aversion. A large shipper could purchase an in-house fleet to guarantee availability of the service and allow the company to profit in the physical freight market. Although some companies own vessels, it is not standard practice in the industry. Even shippers that own vessels rarely own all the capacity they require. For small exporters, limited working capital may limit the speculative element in their utility function. Because of a lack of market power and possibly a lack of reserve funds, smaller shippers are assumed to be very risk averse. Together these two conjectures suggest that the risk aversion parameter in the utility function is near infinity. Therefore, the optimal hedge ratio for the shipper and the ship owner differ only in that they are on opposite sides of the market.

Because the BIFFEX is an index of a basket of freight rates, a hedge on the market is a hedge on world freight prices. Hedgers are not concerned with world price but with individual route prices. In essence, a hedge on the BIFFEX is a cross hedge. Furthermore Condas (1990) found some inefficiency in the market and that $E_t[CP_{t+1}] = FP_t$ does not hold for the minor routes in the index. Therefore, the model chosen for the estimation is the modified price difference model proposed by Bond [10].

Data

The data used are the prices for all contracts traded from May 1, 1985 to December 31, 1989 and the daily values of the BFI and its components over the same period. The data were obtained from the Baltic International Freight Futures Exchange in London. The cash prices used are the indexed values for all routes included in the BFI. All units in the analysis are in index points.

The price difference model requires estimating the optimal hedging ratios over various hedging periods. Optimal ratios for all

routes in the BFI index are determined for six and twenty week hedging periods. Observations are limited because freight futures are relatively new. Sixteen observations are used in the 6 week hedges and 12 observations are used for the 20 week hedges. Past research has suggested that the optimal hedge ratio may be sensitive to the time to delivery when the hedge is lifted (Deneckere et al., 1986). To avoid the possibility of abnormal price behavior near contract settlement, all futures market positions are assumed to be offset two weeks prior to contract expiration. The observations therefore represent a cross-section over specific contracts which have expired since trading began.

Results

Table 3 contains the estimations used to adjust for basis risk, i.e., the assumption that futures prices i weeks prior to offsetting the hedge are unbiased estimators of cash prices at time $t+i$. For the 6-week hedging period futures prices generally are unbiased, explain movements in the route prices, and have good explanatory power. The futures prices are biased estimators for cash prices on routes 5, 8, and 9 as indicated by the significance of the intercept. Also on routes 5, 7, 8, and 9 the futures prices do not have a one-to-one relationship with the route prices.

In the 20-week interval, the futures prices do not fully explain movements in cash price on routes 8 and 9. Normally the bias would be expected to continue as the prediction interval increases. In the 20-week interval the new monthly contracts offered on the exchange are excluded from the data set. This leads to the disparity of the results. As expected, as the time interval to delivery increases the ability of futures prices to predict cash prices decreases. All the values of R^2 , except for route 11, are less in the 20-week period than in the 6-week period. Apparently route 11 acts independently of the BFI in the short run. Over a longer period it moves more or less with the general market.

In Table 4 the optimal hedge ratios for all BFI component routes are shown for the 6-week and 20-week hedging horizons. Because the confidence intervals on the parameters presented in Table 3 (not shown) are wide, both the non-adjusted and adjusted hedging ratios

TABLE 3

**Regressions of Route Freight Prices 2 Weeks Prior
to Delivery on Lagged Futures Prices**

6 Week Lag Futures Price 20 Week Lag Futures Price

Route	6 Week Lag Future Price			20 Week Lag Futures Price		
	α	β	R ²	α	β	R ²
R1	122.0 (0.08)*	0.85 (1.39) ^b	.76	267.7 (0.00)	0.72 (1.19)	.43
R2	-32.2 (1.96)	1.14 (1.53)	.87	25.7 (0.23)	1.14 (0.23)	.57
R3	207.1 (0.68)	0.88 (2.17)	.89	259.5 (0.31)	0.86 (0.43)	.60
R4	184.4 (0.32)	0.92 (0.31)	.73	204.4 (0.18)	0.95 (0.02)	.47
R5	-14.3 (3.02)**	1.29 (3.55)*	.83	120.0 (0.53)	1.24 (0.47)	.50
R6	-62.1 (0.35)	1.01 (0.02)	.93	-55.1 (0.03)	1.03 (0.04)	.75
R7	176.1 (0.41)	0.78 (6.39)*	.85	208.2 (0.00)	0.78 (0.97)	.53
R8	385.9 (6.46)*	0.43 (49.6)*	.67	400.5 (0.60)	0.45 (9.90)*	.37
R9	385.2 (8.08)*	0.42 (58.3)*	.69	396.6 (0.77)	0.44 (11.4)*	.37
R10	130.4 (0.03)	0.87 (2.71)	.89	189.4 (0.02)	0.86 (0.29)	.54
R11	283.0 (0.28)	0.86 (0.37)	.51	-0.7 (0.52)	1.28 (1.00)	.67
R12	16.1 (0.35)	0.91 (0.50)	.80	72.2 (0.29)	0.85 (1.20)	.78

^a F-statistic for: $\alpha - (1-\beta)FP = 0$, in parentheses. * and ** signify significance at the .05 and .10 level, respectively.

^b F-statistic for: $\beta = 1$, in parentheses. * and ** signify significance at the .05 and .10 level, respectively. All slope coefficients are significantly different from zero.

are presented regardless of whether biasness is rejected. Only the adjusted ratios are discussed.

The slope parameters suggest that between 0% to 124% of a ship's space should be hedged depending on the route and the duration of the hedge. On route 11 not hedging is optimal. This result follows from the inability of futures prices to predict route prices over the 6-week period. For routes where bias was detected (routes 5, 8, and 9) the hedging effectiveness, as measured by the R^2 , ranges from .18 to .29. The basis risk on these routes limits the degree by which hedging can decrease price variability. This suggests that it might be ill-advised to hedge on BIFFEX unless the route in question is a major component of the index or prices on a route move in tandem with the BFI. Since hedging on the BIFFEX is ineffective for some BFI component routes, the short-term hedging opportunity on out-of-the-way routes or for different cargos is probably limited.

In the 20-week interval hedging effectiveness is higher for all routes.⁵ On the major route the BIFFEX is effective in reducing cash price variation. The 20-week results are particularly pronounced on the routes where a 6-week hedge has little impact. On routes 8 and 9 the futures prices changes explain 68% and 74% of the variation in the price changes, respectively, compared with 18% and 29% in the shorter interval. Further, hedging effectiveness on route 11 increases from 0% to 57% when the interval is extended. These findings agree with those from other studies on hedging ratios. As the duration of the hedge increases the price variation in the cash market should increase relative to the price variation of the expected basis. The results also suggest that hedging out-of-the-way voyages may be possible if the hedging period is sufficiently long. In the short run, cash prices on infrequently traveled routes may act independently of the BFI. In the long run, however, one would expect these prices to follow general trends in the world shipping market.

OUTCOMES FROM HEDGING

Having determined the optimal hedge ratios for all routes in the BFI, the effect that hedging has on the mean and variance of prices can be resolved. To calculate the mean and variance of the unhedged and hedge prices the

assumption made are (1) producers hedge a percentage of services as prescribed by the optimal hedge ratio; (2) the transaction cost is \$70.00 per contract; (3) losses (earnings) of interest on margin deposits are insignificant compared to the size of the transaction and are omitted; (4) the producer is concerned with the per ton price expressed in index points; and (5) only one contract is needed to hedge a ship. Assumptions four and five are used for simplicity, are not restrictive, and the final results will be generalized to a more realistic hedge on the BIFFEX.

In Table 5 the mean prices for all BFI routes and their respective standard deviations for both the unhedged and hedged alternatives are shown. Peck shows that since some production decisions are fixed, the benefits of hedging must be assessed in terms of price expectations. It was argued earlier that a ship owner's production decisions are not fixed. However, in a six week time span an owner's options are highly limited. Therefore, the standard deviation in [3] is estimated for an unhedged position and then compared to the standard deviation estimated for a hedged position [5]. In the analysis, agents are assumed to forecast route prices with the regression equations in Table 3. The expectations of the basis are obtained from simple first-order autoregressive models. The optimal hedge ratios used in the analysis are the adjusted ratios in Table 4. For the 6 week period the optimal strategy is the unhedged position. Hedging results in a lower mean price and higher standard deviation for all routes.⁶

Table 5 shows the changes in the means and standard deviations of returns from hedging versus not hedging. The reduction in the variability of returns from hedging is substantial. In all cases, the results show a short-term hedge is effective when appraised under Peck's framework.

When the 20-week horizon is compared to the 6-week, for all but one route the risk reduction is greater. However, for all routes the mean return is also lower.⁷ This finding supports the results obtained in the optimal hedge, i.e., as the hedging interval increases the price variation should increase, thereby making hedging more effective.

The results in Table 5 also illustrate a common pitfall of hedging. An agent must be willing to accept a lower mean price to reduce

TABLE 4

Optimal Hedge Ratios for BFI Component Routes

Route	6 Weeks			6 Weeks-Adjusted			20 Weeks			20 Weeks-Adjusted		
	α	β	R ²	α	β	R ²	α	β	R ²	α	β	R ²
R1	31.7 (1.09)*	0.88 (3.26)*	.43	-14.6 (0.78)	1.24 (7.10)*	.79	-35.7 (0.74)	1.20 (4.73)*	.69	-58.9 (3.43)*	1.09 (12.02)*	.94
R2	55.0 (2.56)*	0.62 (3.11)*	.41	-9.6 (0.58)	1.14 (7.30)*	.79	10.9 (0.19)	1.23 (4.11)*	.63	-75.6 (3.59)*	1.27 (11.56)*	.93
R3	47.5 (1.60)	0.51 (1.85)	.20	-9.7 (0.69)	0.76 (5.79)*	.71	3.4 (0.07)	0.85 (3.19)*	.50	-51.2 (2.96)*	0.90 (9.90)*	.91
R4	39.2 (1.07)	0.82 (2.39)*	.29	-16.2 (0.49)	1.14 (3.65)*	.49	36.1 (0.57)	1.18 (3.55)*	.56	-69.6 (1.75)	1.17 (5.60)*	.76
R5	22.0 (0.58)	0.41 (1.17)	.09	-11.4 (0.27)	0.82 (2.09)	.24	6.8 (0.08)	1.12 (2.60)*	.40	-77.6 (1.51)	1.42 (5.29)*	.74
R6	19.3 (0.76)	0.30 (1.27)	.10	-4.4 (0.24)	0.55 (3.20)*	.42	-13.1 (0.47)	0.80 (5.41)*	.75	-37.6 (1.72)	0.71 (6.19)*	.79
R7	14.4 (0.48)	0.60 (2.14)*	.25	-9.4 (0.68)	0.83 (6.40)*	.75	-18.1 (0.36)	1.04 (2.93)*	.61	-51.5 (3.00)*	0.94 (10.39)*	.92
R8	14.7 (0.94)	0.24 (1.65)	.16	-3.1 (0.13)	0.38 (1.77)	.18	-28.6 (1.38)	0.75 (6.89)*	.83	-37.5 (1.47)	0.64 (4.58)*	.68
R9	11.8 (0.53)	0.30 (1.46)	.13	-4.0 (0.20)	0.45 (2.37)*	.29	-24.7 (0.65)	0.70 (3.53)*	.55	-37.2 (1.65)	0.64 (5.39)*	.74
R10	14.2 (0.47)	0.27 (0.94)	.06	-14.0 (0.95)	0.74 (5.35)*	.67	-4.3 (0.11)	1.04 (5.12)*	.72	-58.8 (3.61)*	1.03 (11.99)*	.93
R11	-60.6 (0.90)	-0.19 (0.30)	.01	-6.3 (0.09)	-0.31 (0.48)	.02	79.1 (1.46)	0.69 (2.43)*	.37	-50.0 (1.04)	0.91 (3.60)*	.57
R12	76.7 (2.27)*	0.46 (1.47)	.13	-5.5 (0.18)	0.82 (2.90)*	.37	31.0 (1.02)*	0.70 (4.37)*	.66	-27.5 (1.75)	0.55 (6.65)*	.82

* t-statistic in parentheses. * signifies significance at the .05 level.

TABLE 5

Effect of Hedging on Mean and Standard Deviation of Returns

Route	6 week hedge		20 week hedge	
	mean	standard deviation	mean	standard deviation
R1	-2.2%	-61.9%	-7.1%	-70.1%
R2	-1.8%	-40.8%	-7.1%	-60.2%
R3	-1.2%	-44.4%	-5.2%	-71.0%
R4	-1.8%	-32.8%	-6.6%	-51.7%
R5	-1.1%	-20.0%	-6.7%	-32.2%
R6	-1.0%	-36.2%	-4.7%	-53.6%
R7	-1.5%	-58.1%	-6.1%	-69.8%
R8	-0.8%	-19.5%	-4.8%	-25.1%
R9	-1.0%	-35.1%	-4.9%	-18.7%
R10	-1.3%	-47.7%	-6.3%	-75.2%
R11			-4.6%	-22.5%
R12	-1.5%	-33.4%	-3.8%	-18.8%

the price variance. Depending on the size of the vessel and the optimal hedge ratio it may take 60 or more BIFFEX contracts to hedge the load. If an owner operating on route 2 needs to hedge with 50 contracts 20 weeks in advance, at \$10.00 US/BFI point, on the average the owner would expect to forego \$39,000 in revenue in order to reduce the price variation. Hedging over a twenty-week period may be effective in reducing price risk but it also may decrease or eliminate the profit margins it was designed to protect.

This type of hedging means protection against price changes, whether advantageous or disadvantageous. Ideally a hedger could place a hedge when the subsequent price change would harm him but wait to place the hedge until a favorable price change can occur. Many studies have examined the possibility of such strategic hedging using some type of technical signal.⁸ In a rising market the producer may choose to accept the price risk in an attempt to capture a

higher expected price, i.e., the producer becomes a cash market speculator. In a falling market he may choose to protect himself by hedging. Successful strategic hedging suggests the agent can forecast future market prices with some accuracy.

Condas (Chapter 9) presents some alternative strategic hedges. While some criteria were developed that produced results superior to the hedge and hold strategy over the data period, these methods need not work in the future. Given the low volume of the markets, in actuality trading of this magnitude would increase transactions costs and it may be difficult to open and close positions without moving the market in the process. With a hedge and hold approach, this is a one time cost of hedging. With strategic hedging this can cause the superiority of a strategy to be illusory.

One advantage of using futures contracts over forward contracts is greater transaction liquidity. The chartering parties

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might want to use futures contracts to hedge their risk since it is easier than negotiating a forward contract. Further, it may be difficult to agree on a price on a route where few or no voyages have been made in the past year. The futures market shoulders the burden of the price discovery. One problem when trading on the BIFFEX is that the volume of trade has often been low. The mean daily volume estimated from a continuous nearby series is 320 contracts per day. Furthermore, daily volumes of 100 contracts are not uncommon. A ship owner strategically hedging a cargo space requiring 50 contracts can expect that on the average he will generate one-seventh of a day's market activity and perhaps as much as 50% if his hedging program calls for a trade on a low-volume day. When hedging on a thin market, the ship owner faces the possibility that he will bid the price down (up) while setting (offsetting) the hedge. Condas found if the average loss per contract is three BFI points, more active hedging strategies might still reduce price risk, but do not dominate the no-hedge option because they result in lower mean prices.

CONCLUDING COMMENTS

The Baltic Freight Futures Exchange provides both chartering parties an opportunity to participate in the spot freight market or formula price forward contracts while simultaneously managing price risk. The hedge ratios calculated here ranged from 0% to 88% of cargo space for short-term hedges and from 50% to over 100% of the cargo space for longer hedges. Non-optimal hedge ratios will reduce the effectiveness of a hedge.

The BIFFEX reduces price risk more with longer hedges. Further, prices for voyages on non-index routes or unusual cargos may not move in tandem with the BFI. Chartering parties in these situations may prefer ordinary forward contracts, especially when the shipping date is near. Overall the BIFFEX seems best suited for hedging major routes, especially for shipments well in the future.

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ENDNOTES

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1. **Formula pricing does offer a medium between the two extremes. This method of price protection will not be considered here.**
2. **The argument assumes that when forward contracting the charterer and the operator do not use the BIFFEX to guide contract pricing. This situation obviously existed before futures contract trading and may not apply today. The information supplied by futures prices might be used in pricing forward contracts. Thus, the agreed upon forward price might fall somewhere between the two, say, \$11.50 in this case.**
3. **The basis risk is excluded in the equation for simplicity.**
4. **The model uses forecast errors as a measure of risk.**
5. **This result is tentative. The dependent variables between the periods are not the same.**
6. **The hedged values are missing for the six week hedge on route 11 because the optimal hedge ratio is zero.**
7. **Because the number of observations is limited in the 20-week hedge, to preserve data, the expectation of the basis is simply the mean basis over the period.**
8. **This is commonly referred to as multiple hedging. The authors prefer using the term strategic hedge instead.**