HEDGING PERFORMANCE OF SHRIMP FUTURES CONTRACTS WITH MULTIPLE DELIVERABLE GRADES

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The performance of the black tiger and white shrimp futures contracts traded in the Minneapolis Grain Exchange (MGE) is considered. These two futures contracts have suffered low trader participation since their inception despite the underlying multibillion-dollar cash shrimp market. The article tries to find answers for such lack of interest in the context of the multiple deliverable category character of both contracts. In particular, the hedging effectiveness and the adequacy of the premiums/discounts are measured for the various shrimp size categories traded in each contract. The analyses indicate that the hedging effectiveness of both contracts is relatively modest.

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Part of the explanation for the performance of the contracts resides in high deliverable category exchange option values, which stem from volatility in the price differentials between size categories. The fixed premiums/discounts are not able to provide a remedy to the alternation in the cheapest to deliver category. There is also a liquidity problem that could result from the peculiarities of seafood trade. It is concluded that the lack of trader interest may be influenced by initial high deliverable category exchange option values. Jrl Fut Mark 19: 957–990, 1999

INTRODUCTION

Currently, two shrimp futures contracts are being traded at the Minneapolis Grain Exchange (MGE): One is for white shrimp and the other one is for black tiger shrimp. These two contracts include several deliverable varieties within each contract. Both contracts, however, have failed to attract the expected trade volume based on the existing shrimp cash market flow. This article discusses the possible reasons for the lack of trader interest in these two contracts. In particular, it investigates the role of multiple delivery alternatives in the contracts as a potential causal factor for such lack of interest.

There is an extensive literature dedicated to the study of multiple delivery alternatives in the context of futures contracts. The alternatives regard what, when, where, and how much of the underlying commodity to deliver (Chance & Hemler, 1993, p.127). Many authors focused on financial instruments such as securities (Kilcollin, 1982; Johnston & McConnell, 1989; Hedge, 1990; Margrabe, 1978). These articles, for the most part, try to value the option to exchange one asset for another to allow for the cheapest delivery within the futures contract. Attention has also been paid to multiple delivery futures contracts for commodities (Garbade & Silber, 1983; Gay & Manaster, 1984; Kamara & Siegel, 1987; Lien, 1988; Viswanath & Chatterjee, 1992). A good review on the topic is provided by Chance and Hemler (1993).

The inclusion of multiple varieties of a commodity (for example, quality option) within the same contract is an effort by the issuing futures market to increase liquidity and reduce the probability of price squeezes derived from shortages in the supply of a certain variety. The existence of the delivery alternative allows the investor to diversify the potential price impact of a short squeeze (Tashjian, 1995). However, in a multiple delivery contract, the economic agent expecting delivery has no certainty regarding the variety of the commodity to be received. As a result, there is a trade-off between reducing delivery risk and reducing the likelihood of squeezes. It can also be said that reducing delivery risk involves eliminating delivery alternatives, which leads to trade-offs between long and short hedging interests (Lien, 1988).

When specific contracts allow for the delivery of different varieties of a commodity (non-par category), premiums or discounts apply for products that differ by a standard measure from a defined model variety (par category). Premiums and discounts in futures contracts are of paramount importance, not only in case of delivery, but also for the performance of the contract as a hedging mechanism. Although most contracts are liquidated by offset before maturity, delivery specifications are of importance because they determine the price to which a contract converges on its final settlement date and hence influence the price of the contract prior to final settlement (Garbade & Silber, 1983).

Varieties of a commodity can differ at different levels. Garbade and Silber (1983) suggested two alternative methods for distinguishing among varieties. A commodity could vary on a single underlying characteristic such as fineness of gold or the quantity of soybean oil after refining. In this case, futures prices could be adjusted with the use of exchange ratios based on equivalence systems that reflect differences in quality. Some other commodities, however, have differences that are less objectively quantifiable, such as country of origin for coffee or cocoa, or carcass grade for live slaughter animals. For these types of commodities, it is more problematic to conceive adequate price adjustments. This is especially true if the price differentials among the different varieties are not constant. If the prices of the different varieties tend to fluctuate a lot, premiums and discounts turn out to be less powerful tools in allocating residual risks (Garbade & Silber, 1983). This results in a permanent uncertainty as to the valuations of different grades in futures market relative to cash markets (Lien, 1988). In such conditions, deriving accurate premiums and discounts is an intractable problem (Paul, Kahl, & Tomek, 1981). There is a less quantifiable cost that can affect dramatically the participation of traders in the contract. It is associated with long hedgers who accept delivery having to sell unwanted delivered grades and buying desirable grades in the spot markets (Lien, 1988).

Shrimp is a somewhat composite commodity that belongs to the second group of commodities listed above as characterized by possessing less objectively quantifiable differences. Currently, two shrimp futures contracts are being traded at the Minneapolis Grain Exchange (MGE). One is for white shrimp and the other one for black tiger shrimp. These two contracts include several deliverable varieties. Shrimp varieties are usually separated based on size, species, and origin. Both contracts, however, have failed to attract the expected trade volume based on the existing shrimp cash market flow. This article discusses the possible reasons for the lack of trader interest in these two contracts. In particular, the article investigates the potential role of the multiple delivery alternatives in the contracts as a causal factor for such lack of interest.

In this article, the hedging performance and effects of deliverable commodity diversity within the white and black tiger shrimp futures contracts in the MGE are studied. First the hedging effectiveness of each contract is assessed for each variety within each contract. Then the focus shifts to determine whether the premiums and discounts for each variety are working properly. We do so by estimating the value of the option to exchange par and non-par categories. The analyses are carried out from a producer perspective (that is, short hedger) because in multiple delivery contracts the delivery alternative is controlled by the short, not long, hedger (Chance & Hemler, 1993).

Shrimp Futures Contracts

Currently, the only seafood commodities traded in futures markets are the frozen white and black tiger shrimps on the MGE. However, this is not the first time shrimp have been a commodity traded in futures markets. In the mid 1960s, two futures contracts for frozen brown, pink, and white shrimps were traded on the Chicago Mercantile Exchange (CME) (CME 1964-1966). They were closed in 1966 after two years of existence as a result of low trading volume. These futures contracts depended heavily on domestic fisheries in the Gulf of Mexico. Almost 30 years later, in July 1993, the MGE launched a frozen white shrimp futures contract. The white shrimp contract had a quarterly frequency until August 1996, when the contract became monthly. The initial non-par premiums/discounts for the white shrimp futures contract were altered for the contract maturing in March 1994. A second futures contract dealing with frozen black tiger shrimp opened in November 1994, also in the MGE. As it was the case for the white shrimp contract, the black tiger shrimp contract had a quarterly frequency until March 1996. Since then, black tiger shrimp futures also adopted a monthly frequency. Two distinctive features of the MGE shrimp contracts are that they depend much more heavily on aquacultured production and imports than the CME contracts did in 1964.

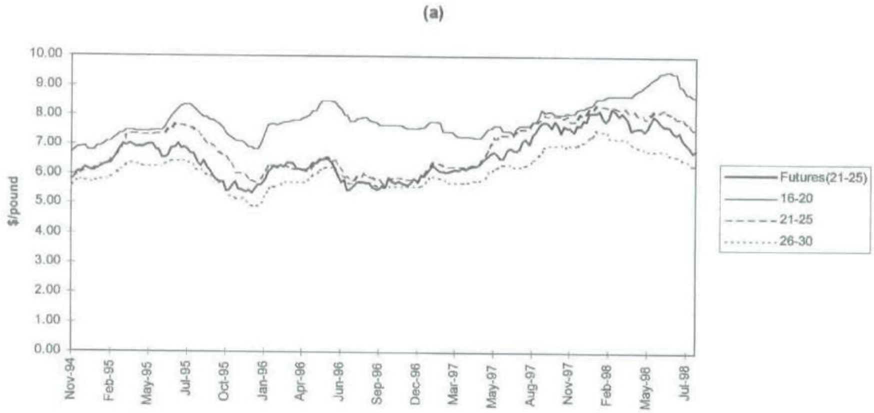
Successful futures contracts are generally characterized by homogeneous and storable product, with broad and transparent cash markets and characterized by price fluctuations with relative high amplitude

(Black, 1986). When the white shrimp contract was inaugurated in 1993, shrimp was regarded as a commodity suited to the requirements for successful futures trading. First, it was a multibillion-dollar industry with high price risk and numerous traders, distributors, producers, and wholesalers (Frozen Food Age, 1993a). Second, dramatic increases in U.S. shrimp consumption and momentous changes in production had increased risk for importers, producers, and end-users, which indicated it was the right time for a shrimp futures market (Frozen Food Age, 1993b).

The introduction of shrimp futures was supposed to bring seafood into the world of mature proteins with a highly liquid and transparent futures market providing objective price information (Restaurant Business Magazine, 1993). Success of the shrimp futures contracts in the MGE can have significant implications for the seafood industry, as it could open the doors of this sophisticated commodity market system to other seafood products. Therefore, shrimp futures are contemplated as a testing experience to introduce a larger variety of seafood products to futures markets.

Product homogeneity could be the greatest challenge facing the shrimp futures contracts, as different species of various origins and sizes are currently being traded in the MGE within the same contracts. Three black tiger shrimp size categories are traded in the MGE; 21–25 count per pound (cpp) is the par size category, and 16–20 cpp and 26–30 cpp are the non-par size categories. White shrimp, on the other hand, are traded in four size categories: 41–50 cpp (par size), and 31–35 cpp, 36–40 cpp and 51–60 cpp are the non-par size categories.

Although different size categories are traded at different prices in the cash markets, they tend to be correlated. Figures 1a and 1b show the cash market weekly price fluctuations for the different shrimp size categories traded in the MGE. In order to standardize the trade of shrimp within each contract, premiums and discounts have been introduced for shrimp that deviate from par size categories and species by the MGE (MGE, 1993, 1997a, 1997b). A main concern in establishing the criteria for premiums and discounts is that they may be subject to constant update for adequate standardization of the various deliverable categories, if price relationships between the different varieties change. Figures 1a and 1b show that price differentials are far from constant for the different varieties of shrimp traded within the same contracts. Premiums and discounts have already changed twice for the white shrimp contract and once for the black tiger contract (Tables I and II). When premiums and discounts are not well calibrated with respect to corresponding cash prices for non-par shrimp size categories, they could turn into perverse incen-



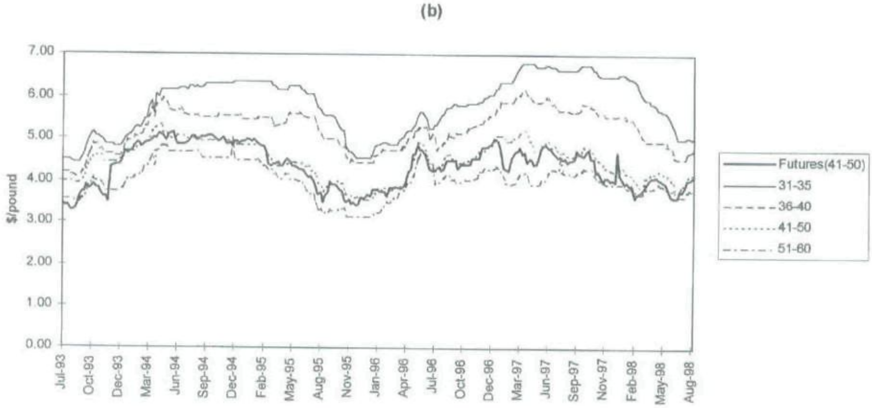


FIGURE 1

Weekly cash market price per pound fluctuations for black tiger (a) and white (b) shrimp size categories that have been traded in the MGE.

TABLE I

Black Tiger Shrimp Futures Non-Par Size Category Delivery Premiums ($/lb) Implemented in the Minneapolis Grain Exchange

Size Category	*Dec 1994–Jul 1997*	*Starting Aug 1997*
16–20	0.80	0.20
26–30	−0.60	−1.10

TABLE II

White Shrimp Futures Non-Par Size Category Delivery Premiums ($/lb) Implemented in the Minneapolis Grain Exchange

Size Category	*Sept 1993–Dec 1993*	*Mar 1994–Jul 1997*	*Starting Aug 1997*
31–35	1.05	0.40	0.35
36–40	0.45	0.15	0.10
51–60	−0.50	−0.65	−0.90

tives for traders holding short positions to deliver non-par product. Traders holding long positions in shrimp futures contracts have shown their concern regarding non-par deliveries. Delivery of non-par shrimp size categories by short-hedgers can result in non-marketable product for traders holding long positions, such as seafood restaurants. Unlike wheat or gold, frozen shrimp is essentially a final product whose individual size is a determinant characteristic for successful marketing. Commodities such as wheat or gold traded in futures markets are not final products. These commodities can be transformed or mixed to achieve the quality or purity required to produce their final products, such as bread or jewelry. This limiting condition of shrimp as a commodity could make systematic opportunities for non-par delivery specially damaging for the survival of black tiger and white shrimp contracts. Traders holding long positions could become discouraged and abandon the trading pit. In fact, after an initial positive response in the white shrimp contract, traders seem not to have become attracted by shrimp futures markets, as indicated by the maximum open interest of each maturing contract throughout the short life history of the two contracts (Figure 2).

METHODS

Futures prices and non-par delivery premiums for frozen black tiger and white shrimp in the MGE (MGE, 1997a), as well as weekly cash prices for par and non-par shrimp size categories (Urner-Barry Publications Inc., 1993–1998) are used for the analyses. This study focuses on all black tiger and white shrimp contracts from the beginning of the futures contracts until the contracts maturing in August 1998.[1] For simplicity, transaction and storage costs are ignored in the computations as in earlier studies (Kamara & Siegel, 1987).

[1]The first black tiger shrimp contract maturing in December 1994 is not included in the data set due to insufficient observations.

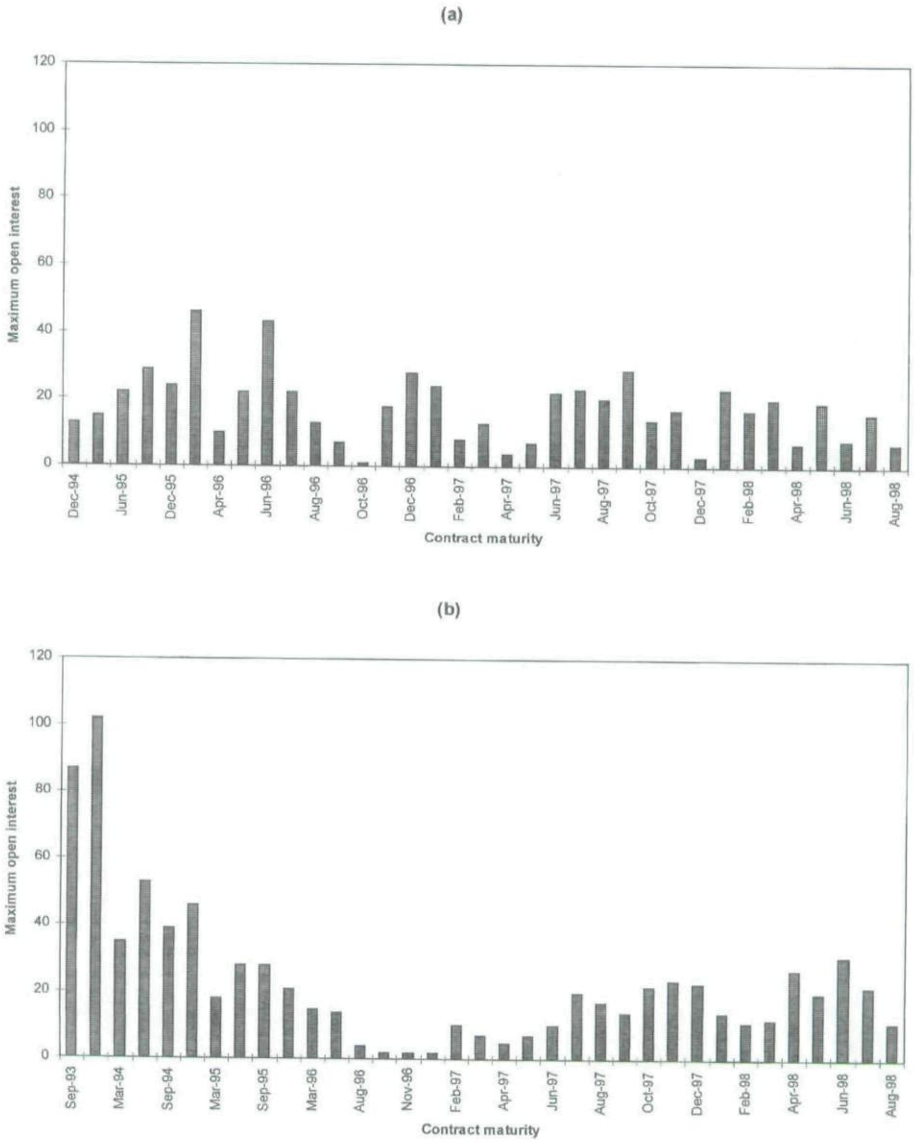


FIGURE 2
Maximum open interest for each contract for black tiger (a) and white (b) shrimp from the birth of each contract.

The analyses simulate simple short-hedging strategies for each contract from the inauguration of the black tiger and white shrimp futures markets in MGE until the August 1998 contracts to determine how their relative performance had been in the past. The analyses assume that the simulated trades deal with par shrimp species, and that the deliveries take place in par delivery locations. Par white shrimp include the species *Pen-*

aeus vannamei, *Penaeus occidentalis*, and *Penaeus stylirostris* from the western hemisphere, whereas the par black tiger shrimp is the species *Penaeus monodon*, from Thailand, the Philippines, and Indonesia.

The par size category for the black tiger shrimp futures contract is 21–25 cpp, whereas the non-par categories permitted for delivery are 16–20 and 26–30 cpp. The different premiums associated with each non-par size category used for the analyses are summarized in Table I. For the white shrimps futures contract, on the other hand, the par category is 41–50 cpp. The non-par size categories accepted by the MGE are 31–35, 36–40, and 51–60 cpp. The premiums corresponding to these non-par size categories for the white shrimp futures contract are summarized in Table II.

The analyses are carried out separately for black tiger and white shrimps. Producers hold short positions in the contracts for two weeks. Participants in these contracts have indicated that the two-week hedge scenario choice is representative of usual hedge periods. Although hedges using shrimp contracts are also held for longer periods, we focused on two-week hedges to increase the sample size of our analyses. Therefore, a typical hedging scenario would involve a hedger buying shrimp in the spot market and selling a number of futures contracts in the same day. Then, two weeks later, the hedger would offset the position in the futures market and sell the shrimp bought two weeks before in the spot market. For example, the first simulated hedge for the black tiger shrimp contract goes short in 6 April 1995 and is offset in 20 April 1995 at the spot prices and closing futures prices for the June 1995 contract determined by the market at those dates. The futures prices used are those from the nearby contract during non-delivery months and the next nearest contract during delivery months. For each maturity contract, three to four hedges per month were estimated by overlapping hedges.

The effectiveness of optimal and full hedges is studied based on the simulated two-week short hedges. Three strategies are simulated: no-hedge, full hedge, and minimum expected variance hedge (that is, optimal hedge). For the hedges, the revenues (R) from each trading strategy are given by

$$R^j = h(f_0 - f_1) + P^j_1 - P^j_0 \tag{1}$$

where h is the hedge ratio, and f_i and P^j_i are the futures and cash prices for the j^{th} grade at time i. The hedge ratio is one for the full hedge strategy. The hedge ratio chosen for the analyses is the traditional minimum risk hedge ratio (Benninga, Eldor, & Zilcha, 1984). For this study, the assumptions of the simplified hedging rule were accepted for its application. This ratio is calculated using first differences of weekly prices provided by Urner-Barry Publications (1993–1998) and the MGE (1997a). In general, the derivation of a hedging ratio should be preceded by relevant tests of underlying price expectations mechanisms (Bond, Thompson, & Lee, 1987). The hedge ratios are estimated from prices over the twenty weeks preceding the hedging day. This effectiveness simulation is referred to as ex-ante effectiveness by Kamara and Siegel (1987), as opposed to ex-post effectiveness (Ederington, 1979; Figlewski, 1984; Koppenhaver, 1985). Kamara and Siegel (1987) presented a hedge ratio appropriate for hedging in futures markets with multiple delivery specifications. This ratio was developed for a two-variety delivery alternative contract under the assumption of bivariate Gaussian distribution of prices. Viswanath and Chatterjee (1992) pointed out that the Kamara-Siegel hedge ratio formula is inapplicable if spot prices are not jointly normal, that it is difficult to extend it to a more than two deliverable asset case (such as the one studied in this article), and that the minimum price of the two assets considered must converge to f_1 at maturity. Furthermore, Viswanath and Chatterjee (1992) conclude that there is not a significant advantage in the use of the Kamara-Siegel formula over the traditional regression hedge ratio in a multiple delivery contract scenario. Considering the practical difficulties for the application of the Kamara-Siegel formula to the shrimp futures contracts and the little gains that could be derived from it, as claimed by Viswanath and Chatterjee (1992), the traditional regression hedge ratio was preferred. The standardized variance of the revenue, R, is used to determine the hedging power of the contracts for each commodity grade.

The existence of consistent perverse incentives for arbitrage that could have damaged the performance of the contracts is also explored. This could be the case if the embedded quality option alternates to be between out-of-the-money and deep in-the-money frequently. The quality option implicit in futures contracts allows the short hedger to satisfy the contract by delivering one of a variety of specified assets. If, at the time the contract is purchased knowledge of which of the allowed assets will be cheapest at maturity is uncertain, then the quality option will have value. In a well-designed contract, premiums/discounts associated with non-par deliveries should cancel out the value of the option to exchange par and non-par categories, provided the price differential is relatively constant. Otherwise, the short hedger will choose to deliver the cheapest of the allowed assets. This creates uncertainty on the long hedgers side as to what delivery to expect. Such uncertainty may detract long hedgers from participating in the contract. Even if the hedged position is lifted before delivery occurs, the existence of valuable options tends, also, to reduce the hedging effectiveness of the contract. This deleterious effect of quality options on the survival of a futures contract has been studied by other authors (Johnston & McConnell, 1989; Gay & Manaster, 1984).

As the exchange option embedded in the futures contract does not trade in any market, its value must be estimated. Gay and Manaster (1984) presented an estimation method based on Margrabe's (1978) extension of the Black and Scholes (1973) option pricing formula. In Gay and Manaster's (1984) work, the option value was estimated for two different varieties of wheat, deliverable within the terms of a futures contract traded on the Chicago Board of Trade (CBOT). Both varieties could be delivered at par and, therefore, did not involve premiums/discounts. In our case, however, premiums/discounts apply for non-par categories. Therefore, the estimation of the exchange option value must take into account these premiums/discounts. In fact, the option values measured are for the right to exchange par for non-par categories, or alternatively non-par for par. The formulation of Gay and Manaster (1984) is altered as follows:

$$W_t(T, p_t, np_t) = p_t N(d_1) - (np_t - \lambda)N(d_2) \tag{2}$$

where $W_t\,(T, p_t, np_t)$ is the value at time t of an option to exchange non-par asset np for par asset p at time T; λ is the premium/discount that applies in case of delivery of the non-par category; $N(\ )$ is the standard normal cumulative density function, and

$$d_1 = \frac{\ln(p_t) - \ln(np_t - \lambda) + 0.5\ \sigma^2(T - t)}{\sigma(T - t)^{0.5}}, \tag{3}$$

$$d_2 = d_1 - \sigma\,(T - t)^{0.5}, \tag{4}$$

where σ is the standard deviation of the difference between the rates of return on assets p and np. The premium/discount λ is a fixed value added to the futures price in case of non-par delivery. λ is set by the exchange to attempt to adjust the futures price to the spot price of the non-par category delivered. In the formulation above, the premium/discount is subtracted from the spot price of the non-par categories to account for the premium/discounts that the holder of the option must account for (if the exchange actually takes place) at the time of delivery. The parameter σ is estimated using the 20-week time series price data preceding t. In the formulation above, the primary asset is the par category (that is, the

TABLE III

Optimal Hedge Ratios for the Three Black Tiger Shrimp Size Categories

	16–20 cpp	*21–25 cpp (par)*	*26–30 cpp*
Mean	0.23	0.19	0.17
Variance	0.019	0.029	0.015
Minimum	−0.01	−0.22	−0.05
Maximum	0.52	0.62	0.51
α	0.10	0.27	0.16

Note: α is the level of significance of a two tail t-test to determine whether the mean optimal hedge ratios is different from zero.

option measures the value of the option to exchange non-par category for par category). However, because which asset is regarded as primary is arbitrary, the option value was calculated reversibly. This is, the value of the option when the primary asset is the non-par category is also estimated (that is, the value of the option to exchange par category for non-par category). If the primary asset is the cheapest of the two considered assets to deliver, then the option will be out-of-the-money. If, on the other hand, the primary asset is more expensive, then the option is in-the-money. Ideally, the option value should not be, on the average, significantly different from zero. When the option is out-of-the-money, it may indicate that the premiums/discounts are working fine. However, there is a chance that the premiums/discounts are excessively large or small in a way that drive the option out-of-the-money. Therefore the value of the option for the reverse exchange of assets is also calculated. For the premiums/discounts to be functioning properly, both options must be out-of-the-money and, therefore, on the average, have values significantly indifferent from zero. The ratio of option to futures value is estimated to show the magnitude of the option value relative to the futures price, as in Gay and Manaster (1984).

RESULTS

Black Tiger Shrimp Contract

Table III reports the statistics associated with the optimal hedge ratios for par and non-par varieties of black tiger shrimp using this futures contract. For the non-par category 16–20 cpp, the mean optimal hedge ratio is far from unity (full hedge). In fact, it is only different from zero at a level of significance greater than 0.10 (two tail t-test). In the case of the 21–25 cpp category, the optimal hedge ratio is even smaller, with a 0.27

TABLE IV

Mean Revenues and Effectiveness of the MGE Black Tiger Shrimp Futures in Short Hedging Par and Non-Par Size Categories

	Unhedged	*Full Hedge*	*Optimal Hedge*
16–20 cpp			
Mean Revenues	0.023	0.024	0.026
Variance	0.053	0.054	0.043
Effectiveness	–	3.59	−18.85
N	107	107	107
21–25 cpp (par)			
Mean Revenues	0.004	0.005	0.005
Variance	0.045	0.044	0.035
Effectiveness	–	−0.09	−20.50
N	107	107	107
26–30 cpp			
Mean Revenues	0.000	0.001	−0.002
Variance	0.035	0.039	0.029
Effectiveness	–	11.21	−16.39
N	107	107	107

Note: Mean revenues are in $ per pound. Effectiveness is the percentage change in variance relative to an unhedged position.

level of significance. The optimal hedge ratio for the 26–30 cpp category, on the other hand, is significantly different from zero at 0.16 level of significance.

Mean revenues (Table IV) seem to be similar for the three hedged strategies. The hedging performance of the black tiger shrimp contract for the 16–20 cpp category shows a 18.85% reduction in risk return. Also, the results from the optimal hedging strategy, on the average, present a 20.50% and 16.39% risk reduction for the 21–25 and 26–30 cpp categories, respectively. The full hedging strategy results in a slight risk reduction only for the par category (21–25 cpp), whereas for the non-par categories the risk increases relative to the unhedged position. Therefore, the relatively small hedge ratios in Table III lead, on the average, to modest risk reductions for all par and non-par categories.

Correlations between cash and futures prices for black tiger shrimp are summarized in Table V. The correlation coefficient between the cash price for 16–20 cpp shrimp and the futures price for black tiger shrimp is 0.64. On the other hand, the cash prices for 21–25 cpp and 26–30 cpp categories present larger correlation coefficients with the futures price, 0.92 and 0.95 respectively. Although these correlation coefficients seem to be relatively high, the fluctuation on the value of the correlation co-

TABLE V

Correlation Coefficients Between Cash and Futures Prices for Different Black Tiger Shrimp Size Categories

Size Category	*Correlation Coefficient*
16–20	0.64
21–25 (par)	0.92
26–30	0.95

efficient between spot and futures prices throughout the period of the analyses is important. Figures 3a to 3c show the simultaneous fluctuation of the correlation coefficient between spot and futures prices and the corresponding hedge ratios. These correlations are calculated for the spot and futures price first differences used to estimate the hedge ratios on which the optimal hedges are based. The large fluctuations can explain both the low average hedge ratios and the relatively modest hedging effectiveness of the contract.

By calculating the quality options associated with the various deliverable grades of the contract we can determine whether premiums/discounts are able to cancel out price differential volatility and as a result whether delivery is functioning correctly. High option values can also affect the hedging effectiveness of the contract. Tables VI and VII present the summary statistics for the value of the exchange options by contract month. Table VI, in particular, shows the value statistics for the exchangeability of par and 16–20 cpp categories. Between March 1995 and September 1995, the value of the option to exchange the 16–20 cpp non-par category for the par category (to be expressed also as $W(p, np\text{-}\lambda)$, beyond this point in the text) is greater than the value of the option to exchange the par category for the 16–20 cpp non-par category (to be expressed also as $W(np\text{-}\lambda, p)$, beyond this point in the text). However, during this period the average value of any option was different from zero only at a high level of significance. Between December 1995 and March 1996, on the other hand, the value of the option to exchange the par category for the 16–20 cpp non-par category is greater than the value of the option to exchange the 16–20 cpp non-par category for the par category. The value of this exchange option, however, is not significantly different from zero, either. However, between April 1996 and February 1997, this option becomes different from zero at significance levels smaller than 0.10, and amounts up to 21% of the futures price. This indicates that the premium is not large enough to cancel out the spread

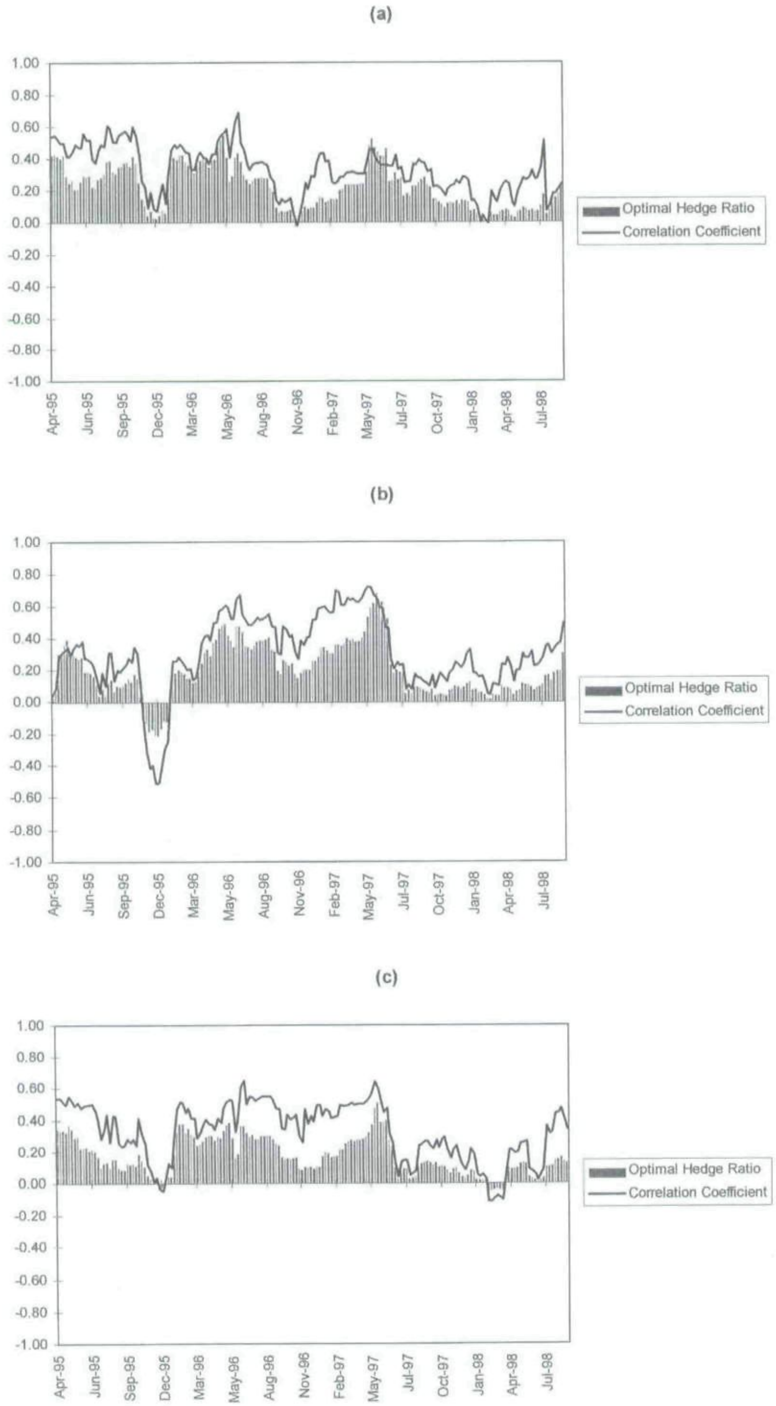


FIGURE 3

20 week correlation coefficients between futures and cash price first differences, and corresponding optimal hedge ratios for (a) 16–20 cpp, (b) 21–25 cpp, and (c) 26–30 cpp black tiger shrimps.

TABLE VI

Summary Statistics by Contract Month for 16–20 cpp Non-Par Size Category for the Black Tiger Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in Brackets)

		Exchange Option ($)		*Option to Futures Value Ratio*	
Contract Month	*Obs.*	$W_t(T, p; np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Mar-95	17	0.152	0.076	0.024	0.012
		(0.080)	(0.061)	(0.012)	(0.010)
		[0.598]	[0.761]	[0.828]	[0.903]
Jun-95	14	0.643	0.012	0.093	0.002
		(0.133)	(0.024)	(0.019)	(0.003)
		[0.100]	[0.938]	[0.516]	[0.977]
Sep-95	28	0.447	0.045	0.066	0.007
		(0.267)	(0.033)	(0.040)	(0.005)
		[0.394]	[0.807]	[0.742]	[0.925]
Dec-95	26	0.139	0.146	0.021	0.025
		(0.151)	(0.069)	(0.022)	(0.013)
		[0.724]	[0.583]	[0.888]	[0.832]
Mar-96	20	0.012	0.393	0.002	0.066
		(0.022)	(0.174)	(0.004)	(0.026)
		[0.934]	[0.357]	[0.972]	[0.686]
Apr-96	8	0.000	0.763	0.000	0.124
		(0.000)	(0.116)	(0.000)	(0.022)
		[1.000]	[0.055]	[1.000]	[0.425]
May-96	10	0.000	0.910	0.000	0.147
		(0.000)	(0.149)	(0.000)	(0.025)
		[1.000]	[0.040]	[1.000]	[0.373]
Jun-96	22	0.000	0.855	0.000	0.135
		(0.001)	(0.235)	(0.000)	(0.036)
		[0.989]	[0.092]	[0.996]	[0.486]
Jul-96	10	0.000	1.165	0.000	0.187
		(0.000)	(0.075)	(0.000)	(0.021)
		[1.000]	[0.002]	[1.000]	[0.225]
Aug-96	10	0.000	1.225	0.000	0.211
		(0.000)	(0.035)	(0.000)	(0.014)
		[1.000]	[0.000]	[1.000]	[0.111]
Sep-96	9	0.000	1.178	0.000	0.209
		(0.000)	(0.062)	(0.000)	(0.015)
		[1.000]	[0.001]	[1.000]	[0.125]
Oct-96	13	0.000	1.158	0.000	0.207
		(0.000)	(0.064)	(0.000)	(0.013)
		[1.000]	[0.001]	[1.000]	[0.093]
Nov-96	13	0.000	1.062	0.000	0.187
		(0.000)	(0.082)	(0.000)	(0.016)
		[1.000]	[0.003]	[1.000]	[0.165]
Dec-96	16	0.000	1.019	0.000	0.178
		(0.000)	(0.095)	(0.000)	(0.018)
		[1.000]	[0.004]	[1.000]	[0.202]
Jan-97	17	0.000	0.956	0.000	0.165
		(0.000)	(0.110)	(0.000)	(0.022)
		[1.000]	[0.010]	[1.000]	[0.279]
Feb-97	22	0.000	0.864	0.000	0.147
		(0.000)	(0.209)	(0.000)	(0.039)
		[1.000]	[0.072]	[1.000]	[0.464]
Mar-97	17	0.000	0.647	0.000	0.108
		(0.000)	(0.247)	(0.000)	(0.043)
		[0.997]	[0.210]	[0.999]	[0.611]

TABLE VI (Continued)

Summary Statistics by Contract Month for 16–20 cpp Non-Par Size Category for the Black Tiger Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in Brackets)

		Exchange Option ($)		*Option to Futures Value Ratio*	
Contract Month	*Obs.*	$W_t(T, p; np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Apr-97	21	0.001	0.564	0.000	0.093
		(0.001)	(0.283)	(0.000)	(0.049)
		[0.981]	[0.302]	[0.992]	[0.677]
May-97	10	0.011	0.187	0.002	0.030
		(0.010)	(0.095)	(0.002)	(0.015)
		[0.917]	[0.558]	[0.967]	[0.814]
Jun-97	10	0.143	0.077	0.021	0.012
		(0.160)	(0.080)	(0.023)	(0.013)
		[0.728]	[0.790]	[0.892]	[0.916]
Jul-97	9	0.419	0.013	0.062	0.002
		(0.216)	(0.025)	(0.032)	(0.004)
		[0.391]	[0.937]	[0.735]	[0.976]
Aug-97	13	0.692	0.000	0.102	0.000
		(0.067)	(0.000)	(0.011)	(0.000)
		[0.019]	[0.992]	[0.345]	[0.997]
Sep-97	11	0.709	0.000	0.106	0.000
		(0.037)	(0.000)	(0.005)	(0.000)
		[0.004]	[0.995]	[0.179]	[0.998]
Oct-97	12	0.688	0.000	0.095	0.000
		(0.068)	(0.000)	(0.013)	(0.000)
		[0.022]	[0.995]	[0.418]	[0.998]
Nov-97	15	0.700	0.000	0.094	0.000
		(0.065)	(0.000)	(0.011)	(0.000)
		[0.015]	[0.990]	[0.375]	[0.996]
Dec-97	18	0.679	0.001	0.092	0.000
		(0.078)	(0.001)	(0.012)	(0.000)
		[0.025]	[0.983]	[0.420]	[0.994]
Jan-98	15	0.648	0.001	0.085	0.000
		(0.068)	(0.002)	(0.010)	(0.000)
		[0.025]	[0.975]	[0.409]	[0.991]
Feb-98	19	0.626	0.003	0.083	0.000
		(0.077)	(0.004)	(0.012)	(0.000)
		[0.036]	[0.963]	[0.464]	[0.986]
Mar-98	14	0.524	0.001	0.067	0.000
		(0.093)	(0.002)	(0.013)	(0.000)
		[0.108]	[0.980]	[0.572]	[0.993]
Apr-98	18	0.475	0.003	0.061	0.000
		(0.129)	(0.003)	(0.018)	(0.000)
		[0.202]	[0.962]	[0.650]	[0.987]
May-98	15	0.271	0.057	0.035	0.007
		(0.190)	(0.113)	(0.024)	(0.015)
		[0.544]	[0.867]	[0.826]	[0.952]
Jun-98	14	0.129	0.176	0.017	0.023
		(0.154)	(0.186)	(0.020)	(0.024)
		[0.747]	[0.689]	[0.907]	[0.885]
Jul-98	18	0.103	0.266	0.014	0.035
		(0.146)	(0.232)	(0.019)	(0.030)
		[0.790]	[0.588]	[0.923]	[0.843]
Aug-98	15	0.002	0.420	0.000	0.056
		(0.003)	(0.150)	(0.000)	(0.020)
		[0.964]	[0.296]	[0.987]	[0.695]

TABLE VII

Summary Statistics by Contract Month for 26–30cpp Non-Par Size Category for the Black Tiger Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in brackets)

		Exchange Option ($)		*Option to Futures Value Ratio*	
Contract Month	*Obs.*	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Mar-95	17	0.046 (0.043) [0.829]	0.204 (0.131) [0.580]	0.007 (0.006) [0.930]	0.033 (0.022) [0.824]
Jun-95	14	0.420 (0.097) [0.200]	0.020 (0.036) [0.916]	0.061 (0.014) [0.621]	0.003 (0.005) [0.968]
Sep-95	28	0.516 (0.100) [0.115]	0.027 (0.043) [0.898]	0.077 (0.015) [0.541]	0.004 (0.006) [0.961]
Dec-95	26	0.499 (0.132) [0.181]	0.002 (0.003) [0.977]	0.081 (0.018) [0.554]	0.000 (0.000) [0.991]
Mar-96	20	0.248 (0.140) [0.515]	0.016 (0.017) [0.903]	0.044 (0.026) [0.788]	0.003 (0.003) [0.959]
Apr-96	8	0.030 (0.037) [0.880]	0.120 (0.039) [0.561]	0.005 (0.006) [0.952]	0.020 (0.007) [0.817]
May-96	10	0.016 (0.022) [0.914]	0.203 (0.079) [0.486]	0.003 (0.003) [0.965]	0.033 (0.013) [0.777]
Jun-96	22	0.072 (0.089) [0.812]	0.179 (0.098) [0.572]	0.011 (0.014) [0.925]	0.028 (0.015) [0.822]
Jul-96	10	0.001 (0.002) [0.972]	0.321 (0.071) [0.255]	0.000 (0.000) [0.989]	0.052 (0.014) [0.671]
Aug-96	10	0.000 (0.000) [0.990]	0.425 (0.059) [0.110]	0.000 (0.000) [0.996]	0.073 (0.013) [0.531]
Sep-96	9	0.000 (0.000) [0.999]	0.428 (0.057) [0.105]	0.000 (0.000) [0.999]	0.076 (0.011) [0.486]
Oct-96	13	0.000 (0.000) [0.994]	0.427 (0.048) [0.074]	0.000 (0.000) [0.997]	0.076 (0.009) [0.437]
Nov-96	13	0.000 (0.001) [0.988]	0.369 (0.052) [0.130]	0.000 (0.000) [0.995]	0.065 (0.010) [0.526]
Dec-96	16	0.001 (0.001) [0.985]	0.366 (0.047) [0.112]	0.000 (0.000) [0.994]	0.064 (0.009) [0.507]
Jan-97	17	0.001 (0.001) [0.983]	0.347 (0.057) [0.165]	0.000 (0.000) [0.993]	0.060 (0.011) [0.571]
Feb-97	22	0.002 (0.002) [0.962]	0.303 (0.101) [0.351]	0.000 (0.000) [0.984]	0.052 (0.018) [0.706]
Mar-97	17	0.008 (0.008) [0.930]	0.215 (0.121) [0.546]	0.001 (0.001) [0.972]	0.036 (0.021) [0.807]

TABLE VII (Continued)

Summary Statistics by Contract Month for 26–30cpp Non-Par Size Category for the Black Tiger Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in brackets)

		Exchange Option ($)		Option to Futures Value Ratio	
Contract Month	*Obs.*	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Apr-97	21	0.015	0.191	0.002	0.032
		(0.013)	(0.121)	(0.002)	(0.021)
		[0.894]	[0.589]	[0.957]	[0.828]
May-97	10	0.032	0.066	0.005	0.011
		(0.020)	(0.025)	(0.003)	(0.004)
		[0.821]	[0.686]	[0.927]	[0.872]
Jun-97	10	0.174	0.034	0.026	0.005
		(0.159)	(0.039)	(0.023)	(0.006)
		[0.673]	0.869	[0.868]	[0.948]
Jul-97	9	0.353	0.002	0.053	0.000
		(0.103)	(0.004)	(0.015)	(0.001)
		[0.301]	[0.975]	[0.678]	[0.990]
Aug-97	13	0.554	0.000	0.081	0.000
		(0.092)	(0.000)	(0.014)	(0.000)
		[0.091]	[0.995]	[0.505]	[0.998]
Sep-97	11	0.568	0.000	0.085	0.000
		(0.093)	(0.000)	(0.014)	(0.000)
		[0.089]	[0.996]	[0.485]	[0.998]
Oct-97	12	0.558	0.000	0.078	0.000
		(0.097)	(0.000)	(0.017)	(0.000)
		[0.099]	[0.999]	[0.562]	[1.000]
Nov-97	15	0.504	0.000	0.068	0.000
		(0.107)	(0.000)	(0.017)	(0.000)
		[0.145]	[0.991]	[0.612]	[0.997]
Dec-97	18	0.468	0.001	0.064	0.000
		(0.130)	(0.001)	(0.020)	(0.000)
		[0.211]	[0.983]	[0.657]	[0.994]
Jan-98	15	0.357	0.003	0.047	0.000
		(0.066)	(0.003)	(0.009)	(0.000)
		[0.184]	[0.963]	[0.634]	[0.986]
Feb-98	19	0.338	0.004	0.045	0.001
		(0.075)	(0.005)	(0.011)	(0.001)
		[0.231]	[0.948]	[0.676]	[0.981]
Mar-98	14	0.335	0.003	0.043	0.000
		(0.071)	(0.003)	(0.009)	(0.000)
		[0.230]	[0.956]	[0.660]	[0.984]
Apr-98	18	0.358	0.005	0.046	0.001
		(0.074)	(0.005)	(0.009)	(0.001)
		[0.203]	[0.946]	[0.640]	[0.980]
May-98	15	0.428	0.002	0.056	0.000
		(0.080)	(0.004)	(0.011)	(0.000)
		[0.150]	[0.973]	[0.603]	[0.990]
Jun-98	14	0.526	0.001	0.069	0.000
		(0.117)	(0.002)	(0.014)	(0.000)
		[0.147]	[0.982]	[0.572]	[0.994]
Jul-98	18	0.583	0.002	0.077	0.000
		(0.147)	(0.003)	(0.019)	(0.000)
		[0.146]	[0.977]	[0.581]	[0.992]
Aug-98	15	0.697	0.000	0.094	0.000
		(0.095)	(0.000)	(0.012)	(0.000)
		[0.039]	[0.994]	[0.413]	[0.998]

TABLE VIII

Optimal Hedge Ratios for the Four White Shrimp Size Categories

	31–35 cpp	*36–40 cpp*	*41–50 cpp (par)*	*51–60 cpp*
Mean	0.054	0.052	0.152	0.091
Variance	0.033	0.016	0.028	0.032
Minimum	−0.478	−0.168	−0.176	−0.294
Maximum	0.575	0.493	0.595	0.488
α	0.77	0.68	0.36	0.61

Note: α is the level of significance of a two tail t-test to determine whether the mean optimal hedge ratios is different from zero.

between 16–20 cpp cash and futures prices. The options to exchange par and 16–20 cpp non-par categories have average values that are not significantly different from zero between March 1997 and July 1997. After the premium/discount change in August 1997 and until February 1998, the values of the options to exchange non-par 16–20 cpp for par are different from zero at a significance level smaller than 0.10. Besides the premium/discount changes, this situation results from the convergence between futures and the 16–20 cpp spot prices (Figure 1a). Therefore the premium for the 16–20 cpp delivery is too large. The largest option to futures value ratio during this period is 10%. From March 1998 to August 1998, the average option values for either exchange return to being significantly non-different from zero.

Table VII presents the value statistics for the exchangeability of par and 26–30 cpp non-par categories. The value of the option to exchange the 26–30 cpp non-par category for the par category is greater than the vice versa exchange option for the periods between June 1995 to March 1996, and June 1997 to August 1998. During these time intervals, the average option value is different from zero at a significance level smaller than 0.10 for August 1997 to October 1997, and August 1998. Between April 1996 and May 1997, the option to exchange the par category for the 26–30 cpp non-par category is deeper in the money. However, the option value is different from zero at a significance level smaller than 0.10 only in October 1996.

White Shrimp Contract

Table VIII reports the statistics associated with the optimal hedge ratios for par and non-par varieties of white shrimp. The ratios are rather small, more so than for the black tiger shrimp. For all size categories, average

TABLE IX

Mean Revenues and Effectiveness of the MGE White Shrimp Futures in Short Hedging Par and Non-Par Size Categories

	Unhedged	*Full Hedge*	*Optimal Hedge*
31–35 cpp			
Mean Revenues	0.008	0.016	0.007
Variance	0.015	0.025	0.014
Effectiveness	—	71.93	−7.16
N	178	178	178
36–40 cpp			
Mean Revenues	0.005	0.013	0.006
Variance	0.014	0.027	0.013
Effectiveness	—	91.42	−5.57
N	178	178	178
41–50 cpp (par)			
Mean Revenues	0.000	0.008	0.002
Variance	0.014	0.017	0.011
Effectiveness	—	21.67	−20.76
N	178	178	178
51–60 cpp			
Mean Revenues	0.002	0.010	0.004
Variance	0.015	0.021	0.014
Effectiveness	—	35.84	−8.09
N	178	178	178

Note: Mean revenues are in $ per pound. Effectiveness is the percentage change in variance relative to an unhedged position.

hedge ratios are different from zero at significance levels higher than 0.36.

Table IX contains the statistics on revenues and hedging effectiveness for the four deliverable size categories. Optimally hedging on this contract reduces return uncertainty, on the average, for all four categories. The largest reduction is for the 41–50 cpp par category with 20.76%, whereas, for the rest, the reduction in risk is much smaller. Full hedges, however, result in higher return risk than in the unhedged strategy, for all size categories.

Cash prices for the 31–35 cpp size category are weakly related to the white shrimp futures prices (Table X). Only a 0.62 correlation coefficient accounts for their market association. Slightly larger is the relationship between 36–40 cpp shrimp cash prices and the white shrimp futures prices, with a correlation coefficient of 0.73. Cash prices for the 41–50 cpp par and the 51–60 cpp non-par categories, on the other hand, show a relationship of 0.90 and 0.89 with futures prices respectively. The cor-

TABLE X

Correlation Coefficients Between Cash and Futures Prices for Different White Shrimp Size Categories

Size Category	*Correlation Coefficient*
31–35	0.62
36–40	0.73
41–50 (par)	0.90
51–60	0.89

relation coefficients for the last two size categories seem to be relatively high to justify the low hedge ratios in Table VIII. However, the fluctuation on the values of the correlation coefficient between spot and futures prices throughout the period of the analyses can be appreciated in Figures 4a to 4d. As it is the case for the black tiger shrimp contract, these correlations are calculated for the first differences of the spot prices and futures prices used to estimate the hedge ratios which the optimal hedges are based on. These large fluctuations should help to explain the increase in variance of returns from full hedges, and the low minimum variance hedge ratios.

Tables XI, XII, and XIII present summary statistics for the value of the par and non-par categories exchange options by contract month. Table XI, in particular, shows the value statistics for the exchangeability of par and 31–35 cpp categories. From September 1993 to December 1993, the value of the option to exchange non-par category for par is greater than the opposite exchange option. This option is, in fact, significantly in-the-money. The ratio of option to futures value indicating the economic significance of the quality option is up to 16%, on the average. After the first premium/discount changes in the white shrimp contract in March 1994, the value of the option to exchange par category for non-par turns out to be greater than the opposite exchange option. This option is deep in-the-money, at a level of significance smaller than 0.05 for most months. The option to futures ratio reaches values of up to 47%. This suggests that the premium associated with the 31–35 cpp category is smaller than it should be for this period. Exactly the same pattern is observed for the options to exchange par and the non-par 36–40 cpp categories (Table XII). However, the value of the in-the-money options are not as great as they are for the 31–35 cpp category. The largest ratio of option value to futures, in this case, is 29%. For the option to exchange par and non-par 51–60 cpp (Table XIII), the deepest in-the-money option

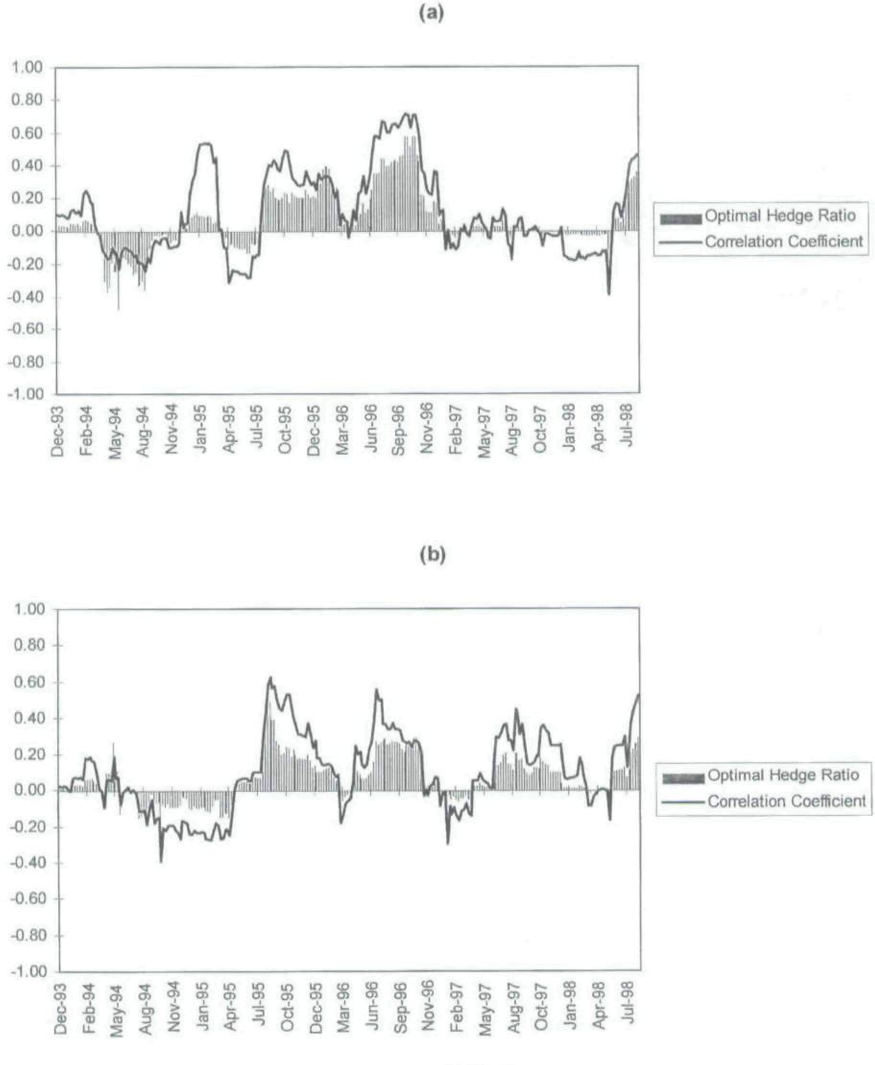
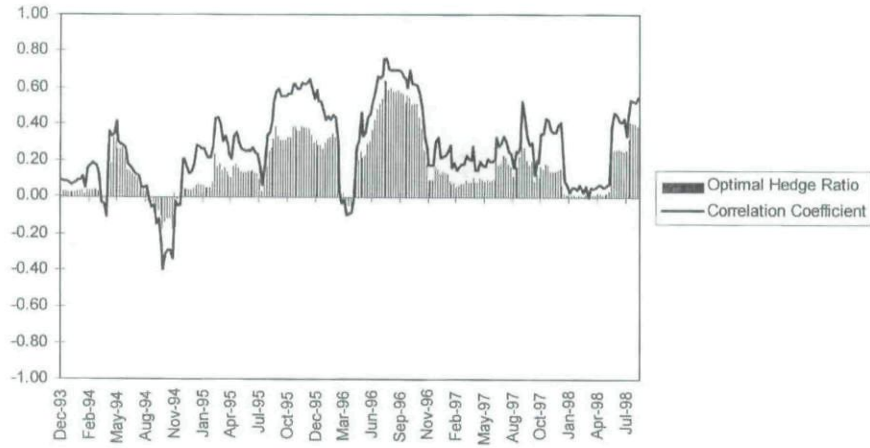


FIGURE 4
20 week correlation coefficients between futures and cash price first differences, and corresponding optimal hedge ratios for (a) 31–35 cpp, (b) 36–40 cpp, and (c) 41–50 cpp white shrimps.

alternates initially between the one exchanging par for non-par, and non-par for par. After the first discount change in the white shrimp futures contract, between March 1994 and January 1997, the option with the largest value is the one exchanging par for the 51–60 cpp non-par category. The average values of this option are different from zero for most months at levels of significance below 0.05. From February 1997 to July 1997, the option with the deepest in-the-money average value is the one

(c)



(d)

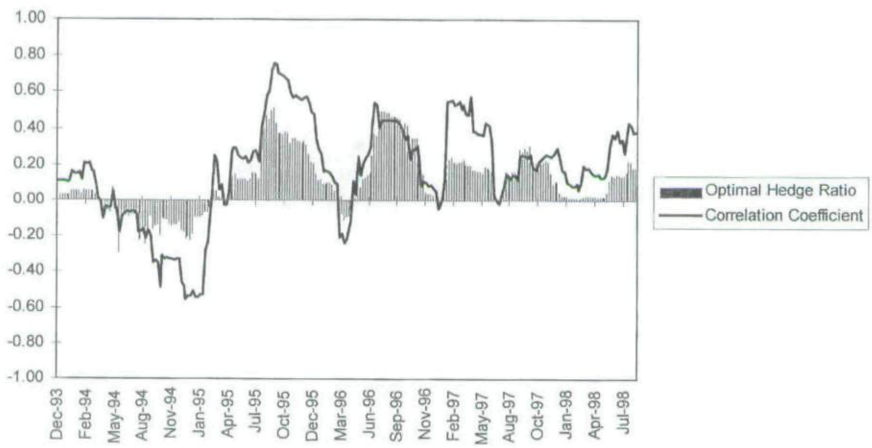


FIGURE 4
Continued.

exchanging non-par for par category. After August 1997, with the second change in premium/discounts in the white shrimp contract, the deepest in-the-money option is again the one exchanging par for non-par category. During this period, the in-the-money option reaches its largest value, with a ratio of option value to futures of nearly up to 17%.

CONCLUSIONS

The low hedge ratios for the black tiger shrimp contract lead to modest risk reductions, whereas full hedging using this contract results, at best,

TABLE XI

Summary Statistics by Contract Month for 31–35 cpp Non-Par Size Category for the White Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in Brackets)

		Exchange Option ($)		*Option Value to Futures Ratio*	
Contract month	*Obs.*	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Sep-93	11	0.552	0.000	0.145	0.000
		(0.001)	(0.000)	(0.002)	(0.000)
		[0.000]	[0.522]	[0.014]	[0.519]
Dec-93	22	0.581	0.033	0.162	0.009
		(0.003)	(0.019)	(0.000)	(0.002)
		[0.000]	[0.815]	[0.000]	[0.816]
Mar-94	24	0.081	0.326	0.018	0.071
		(0.001)	(0.059)	(0.000)	(0.003)
		[0.031]	[0.193]	[0.027]	[0.209]
Jun-94	35	0.090	0.575	0.020	0.120
		(0.003)	(0.078)	(0.000)	(0.003)
		[0.129]	[0.047]	[0.121]	[0.044]
Sep-94	32	0.072	0.924	0.015	0.191
		(0.005)	(0.015)	(0.000)	(0.001)
		[0.322]	[0.000]	[0.322]	[0.000]
Dec-94	45	0.081	1.033	0.018	0.219
		(0.006)	(0.026)	(0.000)	(0.002)
		[0.291]	[0.000]	[0.299]	[0.000]
Mar-95	35	0.030	1.027	0.006	0.211
		(0.002)	(0.012)	(0.000)	(0.001)
		[0.459]	[0.000]	[0.462]	[0.000]
Jun-95	28	0.000	1.280	0.000	0.285
		(0.000)	(0.022)	(0.000)	(0.002)
		[0.831]	[0.000]	[0.831]	[0.000]
Sep-95	28	0.000	1.368	0.000	0.332
		(0.000)	(0.007)	(0.000)	(0.001)
		[0.701]	[0.000]	[0.701]	[0.000]
Dec-95	20	0.000	0.930	0.000	0.252
		(0.000)	(0.096)	(0.000)	(0.005)
		[0.584]	[0.007]	[0.601]	[0.003]
Mar-96	21	0.004	0.647	0.001	0.178
		(0.000)	(0.001)	(0.000)	(0.000)
		[0.349]	[0.000]	[0.348]	[0.000]
Jun-96	19	0.022	0.539	0.005	0.133
		(0.001)	(0.024)	(0.000)	(0.002)
		[0.470]	[0.003]	[0.426]	[0.010]
Aug-96	9	0.001	0.629	0.000	0.146
		(0.000)	(0.017)	(0.000)	(0.001)
		[0.425]	[0.001]	[0.413]	[0.001]
Sep-96	5	0.003	0.800	0.001	0.179
		(0.000)	(0.014)	(0.000)	(0.001)
		[0.588]	[0.001]	[0.588]	[0.001]
Nov-96	7	0.000	0.871	0.000	0.194
		(0.000)	(0.003)	(0.000)	(0.000)
		[0.508]	[0.000]	[0.509]	[0.000]
Jan-97	6	0.000	0.750	0.000	0.153
		(0.000)	(0.006)	(0.000)	(0.000)
		[0.509]	[0.000]	[0.510]	[0.000]
Feb-97	10	0.000	0.820	0.000	0.177
		(0.000)	(0.014)	(0.000)	(0.001)
		[0.348]	[0.000]	[0.348]	[0.001]

TABLE XI (Continued)

Summary Statistics by Contract Month for 31–35 cpp Non-Par Size Category for the White Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in Brackets)

		Exchange Option ($)		*Option Value to Futures Ratio*	
Contract month	*Obs.*	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Mar-97	7	0.000 (0.000) [0.711]	0.971 (0.008) [0.000]	0.000 (0.000) [0.710]	0.217 (0.001) [0.000]
Apr-97	5	0.000 (0.000) [0.671]	1.090 (0.008) [0.000]	0.000 (0.000) [0.671]	0.234 (0.000) [0.000]
May-97	9	0.000 (0.000) [0.620]	1.303 (0.036) [0.000]	0.000 (0.000) [0.621]	0.283 (0.002) [0.000]
Jun-97	15	0.000 (0.000) [0.619]	1.370 (0.029) [0.000]	0.000 (0.000) [0.619]	0.294 (0.002) [0.000]
Jul-97	14	0.000 (0.000) [0.747]	1.454 (0.014) [0.000]	0.000 (0.000) [0.746]	0.313 (0.001) [0.000]
Aug-97	14	0.000 (0.000) [0.605]	1.453 (0.114) [0.001]	0.000 (0.000) [0.604]	0.310 (0.005) [0.001]
Sep-97	18	0.000 (0.000) [0.583]	1.503 (0.093) [0.000]	0.000 (0.000) [0.586]	0.322 (0.004) [0.000]
Oct-97	14	0.000 (0.000) [0.548]	1.530 (0.121) [0.001]	0.000 (0.000) [0.546]	0.332 (0.006) [0.001]
Nov-97	20	0.002 (0.000) [0.422]	1.602 (0.089) [0.000]	0.000 (0.000) [0.422]	0.353 (0.005) [0.000]
Dec-97	17	0.003 (0.000) [0.402]	1.761 (0.003) [0.000]	0.001 (0.000) [0.404]	0.398 (0.001) [0.000]
Jan-98	13	0.001 (0.000) [0.630]	1.785 (0.005) [0.000]	0.000 (0.000) [0.627]	0.417 (0.002) [0.000]
Feb-98	15	0.000 (0.000) [0.578]	1.882 (0.002) [0.000]	0.000 (0.000) [0.571]	0.459 (0.001) [0.000]
Mar-98	17	0.001 (0.000) [0.564]	1.911 (0.003) [0.000]	0.000 (0.000) [0.556]	0.467 (0.001) [0.000]
Apr-98	20	0.001 (0.000) [0.591]	1.870 (0.044) [0.000]	0.000 (0.000) [0.588]	0.467 (0.003) [0.000]
May-98	24	0.001 (0.000) [0.610]	1.771 (0.112) [0.000]	0.000 (0.000) [0.608]	0.439 (0.007) [0.000]
Jun-98	20	0.000 (0.000) [0.762]	1.596 (0.147) [0.000]	0.000 (0.000) [0.762]	0.401 (0.010) [0.001]
Jul-98	26	0.000 (0.000) [0.649]	1.442 (0.209) [0.004]	0.000 (0.000) [0.648]	0.365 (0.012) [0.003]
Aug-98	16	0.000 (0.000) [0.670]	0.915 (0.060) [0.002]	0.000 (0.000) [0.669]	0.235 (0.004) [0.002]

TABLE XII

Summary Statistics by Contract Month for 36–40 cpp Non-Par Size Category for the White Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in Brackets)

		Exchange Option ($)		Option Value to Futures Ratio	
Contract Month	*Obs.*	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Sep-93	11	0.280	0.007	0.073	0.002
		(0.001)	(0.000)	(0.001)	(0.000)
		[0.000]	[0.426]	[0.015]	[0.424]
Dec-93	22	0.265	0.032	0.074	0.009
		(0.005)	(0.005)	(0.000)	(0.000)
		[0.001]	[0.662]	[0.001]	[0.664]
Mar-94	24	0.109	0.217	0.024	0.047
		(0.004)	(0.013)	(0.000)	(0.001)
		[0.117]	[0.072]	[0.119]	[0.074]
Jun-94	35	0.153	0.380	0.033	0.079
		(0.010)	(0.029)	(0.000)	(0.001)
		[0.138]	[0.032]	[0.143]	[0.020]
Sep-94	32	0.166	0.547	0.035	0.114
		(0.017)	(0.018)	(0.001)	(0.001)
		[0.217]	[0.000]	[0.222]	[0.001]
Dec-94	45	0.182	0.589	0.040	0.125
		(0.027)	(0.022)	(0.001)	(0.001)
		[0.271]	[0.000]	[0.279]	[0.001]
Mar-95	35	0.049	0.514	0.010	0.106
		(0.005)	(0.005)	(0.000)	(0.000)
		[0.486]	[0.000]	[0.488]	[0.000]
Jun-95	28	0.000	0.734	0.000	0.165
		(0.000)	(0.053)	(0.000)	(0.003)
		[0.725]	[0.004]	[0.726]	[0.009]
Sep-95	28	0.000	0.970	0.000	0.237
		(0.000)	(0.012)	(0.000)	(0.002)
		[0.685]	[0.000]	[0.685]	[0.000]
Dec-95	20	0.000	0.830	0.000	0.227
		(0.000)	(0.019)	(0.000)	(0.001)
		[0.731]	[0.000]	[0.732]	[0.000]
Mar-96	21	0.000	0.743	0.000	0.205
		(0.000)	(0.002)	(0.000)	(0.000)
		[0.528]	[0.000]	[0.531]	[0.000]
Jun-96	19	0.000	0.582	0.000	0.144
		(0.000)	(0.040)	(0.000)	(0.003)
		[0.454]	[0.009]	[0.455]	[0.023]
Aug-96	9	0.002	0.396	0.000	0.092
		(0.000)	(0.027)	(0.000)	(0.002)
		[0.336]	[0.040]	[0.339]	[0.043]
Sep-96	5	0.006	0.357	0.001	0.080
		(0.000)	(0.009)	(0.000)	(0.001)
		[0.575]	[0.014]	[0.575]	[0.016]
Nov-96	7	0.001	0.573	0.000	0.128
		(0.000)	(0.001)	(0.000)	(0.000)
		[0.590]	[0.000]	[0.590]	[0.000]
Jan-97	6	0.000	0.492	0.000	0.101
		(0.000)	(0.004)	(0.000)	(0.000)
		[0.490]	[0.000]	[0.493]	[0.000]
Feb-97	10	0.002	0.587	0.000	0.127
		(0.000)	(0.019)	(0.000)	(0.001)
		[0.501]	[0.002]	[0.503]	[0.008]

TABLE XII (Continued)

Summary Statistics by Contract Month for 36–40 cpp Non-Par Size Category for the White Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in Brackets)

		Exchange Option ($)		*Option Value to Futures Ratio*	
Contract Month	*Obs.*	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Mar-97	7	0.000	0.750	0.000	0.168
		(0.000)	(0.005)	(0.000)	(0.000)
		[0.585]	[0.000]	[0.581]	[0.000]
Apr-97	5	0.000	0.780	0.000	0.168
		(0.000)	(0.001)	(0.000)	(0.000)
		[0.572]	[0.000]	[0.575]	[0.000]
May-97	9	0.000	0.836	0.000	0.181
		(0.000)	(0.007)	(0.000)	(0.001)
		[0.590]	[0.000]	[0.591]	[0.000]
Jun-97	15	0.000	0.880	0.000	0.189
		(0.000)	(0.008)	(0.000)	(0.001)
		[0.549]	[0.000]	[0.547]	[0.000]
Jul-97	14	0.000	0.904	0.000	0.194
		(0.000)	(0.005)	(0.000)	(0.000)
		[0.693]	[0.000]	[0.693]	[0.000]
Aug-97	14	0.000	1.006	0.000	0.216
		(0.000)	(0.077)	(0.000)	(0.004)
		[0.507]	[0.003]	[0.504]	[0.006]
Sep-97	18	0.001	0.988	0.000	0.212
		(0.000)	(0.061)	(0.000)	(0.003)
		[0.685]	[0.001]	[0.688]	[0.002]
Oct-97	14	0.005	0.997	0.001	0.217
		(0.000)	(0.078)	(0.000)	(0.004)
		[0.521]	[0.003]	[0.523]	[0.004]
Nov-97	20	0.019	1.014	0.004	0.223
		(0.001)	(0.052)	(0.000)	(0.003)
		[0.416]	[0.000]	[0.417]	[0.000]
Dec-97	17	0.040	1.046	0.009	0.237
		(0.001)	(0.003)	(0.000)	(0.001)
		[0.278]	[0.000]	[0.274]	[0.000]
Jan-98	13	0.023	1.087	0.005	0.254
		(0.001)	(0.005)	(0.000)	(0.001)
		[0.393]	[0.000]	[0.378]	[0.000]
Feb-98	15	0.019	1.165	0.005	0.284
		(0.001)	(0.002)	(0.000)	(0.000)
		[0.414]	[0.000]	[0.403]	[0.000]
Mar-98	17	0.023	1.188	0.005	0.291
		(0.001)	(0.004)	(0.000)	(0.001)
		[0.403]	[0.000]	[0.392]	[0.000]
Apr-98	20	0.020	1.150	0.005	0.288
		(0.001)	(0.039)	(0.000)	(0.003)
		[0.448]	[0.000]	[0.446]	[0.000]
May-98	24	0.025	1.071	0.006	0.266
		(0.001)	(0.075)	(0.000)	(0.005)
		[0.485]	[0.001]	[0.483]	[0.001]
Jun-98	20	0.006	0.957	0.001	0.241
		(0.000)	(0.088)	(0.000)	(0.006)
		[0.731]	[0.004]	[0.731]	[0.006]
Jul-98	26	0.007	0.891	0.002	0.226
		(0.000)	(0.086)	(0.000)	(0.005)
		[0.754]	[0.005]	[0.753]	[0.005]
Aug-98	16	0.000	0.600	0.000	0.155
		(0.000)	(0.015)	(0.000)	(0.001)
		[0.580]	[0.000]	[0.577]	[0.000]

TABLE XIII

Summary Statistics by Contract Month for 51–60 cpp Non-Par Size Category for the White Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in Brackets)

		Exchange Option ($)		*Option Value to Futures Ratio*	
Contract Month	*Obs.*	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Sep-93	11	0.096	0.119	0.028	0.033
		−(0.004)	(0.005)	(0.000)	(0.001)
		[0.144]	[0.121]	[0.178]	[0.181]
Dec-93	22	0.159	0.095	0.045	0.027
		(0.004)	(0.011)	(0.000)	(0.001)
		[0.026]	[0.384]	[0.038]	[0.396]
Mar-94	24	0.059	0.070	0.013	0.016
		(0.001)	(0.002)	(0.000)	(0.000)
		[0.075]	[0.160]	[0.082]	[0.172]
Jun-94	35	0.075	0.144	0.016	0.030
		(0.002)	(0.012)	(0.000)	(0.000)
		[0.106]	[0.196]	[0.107]	[0.165]
Sep-94	32	0.077	0.275	0.016	0.057
		(0.003)	(0.014)	(0.000)	(0.001)
		[0.179]	[0.025]	[0.181]	[0.025]
Dec-94	45	0.096	0.314	0.021	0.066
		(0.005)	(0.017)	(0.000)	(0.001)
		[0.165]	[0.019]	[0.178]	[0.021]
Mar-95	35	0.076	0.353	0.016	0.072
		(0.003)	(0.010)	(0.000)	(0.000)
		[0.154]	[0.001]	[0.157]	[0.001]
Jun-95	28	0.100	0.374	0.021	0.082
		(0.005)	(0.008)	(0.000)	(0.000)
		[0.179]	[0.000]	[0.166]	[0.000]
Sep-95	28	0.068	0.236	0.016	0.055
		(0.003)	(0.033)	(0.000)	(0.002)
		[0.209]	[0.207]	[0.182]	[0.185]
Dec-95	20	0.041	0.159	0.011	0.045
		(0.001)	(0.007)	(0.000)	(0.001)
		[0.255]	[0.072]	[0.242]	[0.093]
Mar-96	21	0.027	0.253	0.008	0.070
		(0.000)	(0.005)	(0.000)	(0.000)
		[0.228]	[0.002]	[0.238]	[0.004]
Jun-96	19	0.012	0.377	0.003	0.091
		(0.000)	(0.009)	(0.000)	(0.001)
		[0.512]	[0.001]	[0.512]	[0.001]
Aug-96	9	0.006	0.392	0.001	0.091
		(0.000)	(0.035)	(0.000)	(0.002)
		[0.257]	[0.064]	[0.259]	[0.065]
Sep-96	5	0.032	0.173	0.007	0.039
		(0.000)	(0.000)	(0.000)	(0.000)
		[0.162]	[0.000]	[0.161]	[0.000]
Nov-96	7	0.035	0.190	0.008	0.042
		(0.000)	(0.002)	(0.000)	(0.000)
		[0.076]	[0.002]	[0.080]	[0.003]
Jan-97	6	0.079	0.089	0.016	0.018
		(0.002)	(0.010)	(0.000)	(0.000)
		[0.102]	[0.400]	[0.098]	[0.402]
Feb-97	10	0.181	0.064	0.040	0.013
		(0.013)	(0.009)	(0.001)	(0.000)
		[0.140]	[0.521]	[0.178]	[0.524]

TABLE XIII (Continued)

Summary Statistics by Contract Month for 51–60 cpp Non-Par Size Category for the White Shrimp Contract (Mean Values, Variance in Parentheses and Level of Significance in Brackets)

		Exchange Option ($)		*Option Value to Futures Ratio*	
Contract Month	*Obs.*	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$	$W_t(T, p, np\text{-}\lambda)$	$W_t(T, np\text{-}\lambda, p)$
Mar-97	7	0.336 (0.005) [0.002]	0.000 (0.000) [0.691]	0.075 (0.000) [0.002]	0.000 (0.000) [0.688]
Apr-97	5	0.360 (0.002) [0.000]	0.000 (0.000) [0.654]	0.077 (0.000) [0.000]	0.000 (0.000) [0.655]
May-97	9	0.320 (0.005) [0.002]	0.000 (0.000) [0.424]	0.069 (0.000) [0.001]	0.000 (0.000) [0.421]
Jun-97	15	0.247 (0.014) [0.057]	0.050 (0.028) [0.766]	0.053 (0.001) [0.055]	0.010 (0.001) [0.765]
Jul-97	14	0.192 (0.013) [0.113]	0.104 (0.031) [0.565]	0.041 (0.001) [0.116]	0.022 (0.001) [0.560]
Aug-97	14	0.083 (0.004) [0.212]	0.413 (0.041) [0.059]	0.018 (0.000) [0.210]	0.089 (0.002) [0.056]
Sep-97	18	0.109 (0.006) [0.191]	0.449 (0.032) [0.022]	0.023 (0.000) [0.189]	0.096 (0.001) [0.021]
Oct-97	14	0.123 (0.007) [0.160]	0.497 (0.005) [0.000]	0.027 (0.000) [0.160]	0.108 (0.000) [0.000]
Nov-97	20	0.164 (0.010) [0.113]	0.541 (0.004) [0.000]	0.036 (0.000) [0.113]	0.119 (0.000) [0.000]
Dec-97	17	0.133 (0.008) [0.152]	0.550 (0.001) [0.000]	0.029 (0.000) [0.141]	0.124 (0.000) [0.000]
Jan-98	13	0.090 (0.007) [0.300]	0.556 (0.000) [0.000]	0.020 (0.000) [0.283]	0.130 (0.000) [0.000]
Feb-98	15	0.051 (0.006) [0.536]	0.583 (0.001) [0.000]	0.012 (0.000) [0.533]	0.142 (0.000) [0.000]
Mar-98	17	0.051 (0.007) [0.562]	0.599 (0.002) [0.000]	0.012 (0.000) [0.560]	0.147 (0.000) [0.000]
Apr-98	20	0.007 (0.001) [0.779]	0.612 (0.003) [0.000]	0.002 (0.000) [0.778]	0.153 (0.000) [0.000]
May-98	24	0.008 (0.001) [0.784]	0.605 (0.003) [0.000]	0.002 (0.000) [0.783]	0.150 (0.000) [0.000]
Jun-98	20	0.000 (0.000) [0.725]	0.620 (0.004) [0.000]	0.000 (0.000) [0.723]	0.156 (0.000) [0.000]
Jul-98	26	0.000 (0.000) [0.612]	0.646 (0.006) [0.000]	0.000 (0.000) [0.606]	0.165 (0.001) [0.000]
Aug-98	16	0.000 (0.000) [0.699]	0.634 (0.012) [0.000]	0.000 (0.000) [0.698]	0.164 (0.001) [0.000]

in negligible reduction on risk of return. Analyses for the white shrimp futures contract suggest even smaller hedge ratios than for the black tiger contract. The hedge effectiveness is similar for the par categories, but smaller for non-par categories in the case of the white shrimp contract. Full hedges in the white shrimp contract, on the other hand, result in severe increases in the risk of return for any size category.

Although the correlation coefficients between futures and cash prices of the size categories considered may seem robust for certain size categories, there exist large fluctuations in their values in shorter periods that coincide with the hedge ratio estimation periods. Sudden and progressive changes in the price relationships affect both par and non-par categories. There is an unsteady correlation in the price evolution of the different size categories. Such unstable association between the different size categories may stem from the existence of different markets for these different categories. Therefore, as it was speculated in the introduction, the product homogeneity condition required for a successful contract may in fact be an issue for these two contracts. In other words, the market substitutability of the different size categories may not be as strong as presumed by the MGE contract. Fixed premiums/discounts can be of little help if that is the case. The high exchange option values observed for both contracts are a result of the weak price association between different cash prices, in a way that fixed premiums/discounts are unable to cancel out. The relative independence of the price movements between the derivative and cash markets, on the other hand, may also be related to liquidity problems in the contracts.

Liquidity problems contribute to the lack of hedging effectiveness throughout the life of these two contracts. However, the initial relatively high participation and subsequent quick drop in the trading interest of the white shrimp contract may be explained by in-the-money option to exchange values at the beginning of the contract; which, in turn, may also be caused by an insufficient initial liquidity of the contract. In all likelihood, the initial failure of the white shrimp contract to keep traders in the pit probably influenced participation in the black tiger contract, too.

This brings us back to the argument made by Garbade and Silber (1983), suggesting that volatility in the price differential among varieties makes a case for separate single-delivery contracts based, for shrimp, on size categories. However, this would reduce the volume of trade in each single delivery contract with respect to the multiple delivery contract. It is known that liquid contracts represent substantially cheaper alternatives for establishing a reasonable hedge than do thinly traded contracts, even if the thinly traded contract offers potentially superior hedging capability (Tashjian, 1995). In fact, futures contracts with actively traded close substitutes are less likely to succeed than are new futures contracts without close substitutes (Black, 1986).

Theoretically, the current design of both contracts should enhance the liquidity of these two futures contracts. However, as it has been shown so far, the contracts failed to attract trade volume despite the multibillion-dollar character of the underlying spot market. The MGE may want to consider single-delivery contracts as an alternative that could improve the hedging effectiveness of the contracts. This, in turn, may attract a greater volume of traders and increase a much needed liquidity for the survival of the shrimp futures contracts. The availability fluctuations of single size categories that are characteristic of shrimp supply may prevent contract viability, however.

Although it was not explored in this article, it should be noted that another difficulty for the success of any seafood as a commodity in futures markets is its lack of transparent cash markets. Broad and transparent cash markets are an essential of the foundation for the success of a futures contract. Seafood trading is a highly disaggregated market in which individual traders' bids are generally not made public. Therefore, it is difficult to be sure the futures prices for shrimp actually follow those of the cash market. The structure of many cash seafood markets is a major disadvantage for the successful implementation of not only shrimp but any other seafood product futures contract. In fact, the prices reported by Urner-Barry Publications, Inc. (1993–1998), and used for this article, may not fully represent the actual cash shrimp market. Such an opaque underlying cash market is incompatible with the information requirements of a successful futures contract. The usual seafood trading practices in the cash markets may suggest that a large segment of the participants are not interested in, or aware of, the beneficial aspects of transparent cash markets and futures contracts. Lack of liquidity/trader participation in the shrimp contracts, therefore, may also be a reflection of the general seafood sector attitude toward more sophisticated trading mechanisms. The experience accumulated from the existence of the two shrimp futures contracts can help to understand the limitations associated with seafood commodities. This knowledge can potentially help to design new futures contracts for shrimp as well as other important seafood commodities, such as salmon.

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