

An Examination of the Shrimp Futures Market

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Abstract. The only two seafood commodities traded in futures markets are frozen white and black tiger shrimps on the Minneapolis Grain Exchange (MGE). These two contracts, however, have failed to attract the expected trade volume based on the underlying shrimp cash market flow. First, we investigate the hedging effectiveness of these contracts. Then we also try to determine the adequacy of the premiums/discounts for non-par deliveries associated with the various shrimp size categories traded in each contract. Finally, we attempt to determine whether these contracts are unbiased predictors of cash market prices. The analyses indicate that the hedging effectiveness of both contracts is relatively modest. It is concluded that 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. Results indicate ineffective premiums/discounts and poor predictive ability of both contracts.

Keywords: shrimp, futures contracts, hedging effectiveness, premiums/discounts, predictive ability.

1. INTRODUCTION

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 within each contract. Shrimp varieties are usually separated based on size, species, and origin. Par white shrimp include the species *Penaeus vannamei*, *Penaeus occidentalis* and *Penaeus stylirostris* from the western hemisphere, while 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 (count per pound) cpp, while the non-par categories permitted for delivery are 16-20 and 26-30 cpp. For the white shrimp 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. 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). Premiums and discounts have already changed twice for the white shrimp contract and once for the black tiger contract.

Both contracts, however, have failed to attract the expected trade volume based on the existing shrimp cash market flow. The motivation of this study is to find out the underlying reasons for such a lukewarm reception from traders.

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. Finally, we estimate the ability of each contract to predict spot prices.

2. HEDGING EFFECTIVENESS¹

The analyses are carried out from a producer perspective (i.e., short hedger) because in multiple delivery contracts the delivery alternative is controlled by the short, not long, hedger (Chance and Hemler, 1993). 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 4/6/95 and is offset in 4/20/95 at the spot prices and closing futures prices for the June-95 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.

¹ More details on these analyses can be found in Martínez-Garmendia and Anderson (1999).

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 (i.e. the hedge ratio is equal to one) and minimum expected variance hedge. For the hedges, the revenues (R) from each trading strategy are given by

$$R^j = h (f_0 - f_1) + P_1^j - P_0^j \quad (1)$$

where h is the hedge ratio, and f_i and P_i^j 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 and 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).

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), while for the non-par categories the risk increases relative to the unhedged position.

In the case of the white shrimp contract, minimum variance 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%, while 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.

3. PREMIUMS/DISCOUNTS²

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

² More details on these analyses can be found in Martínez-Garmendia and Anderson (1999).

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 and McConnell, 1989; Gay and 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:

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

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

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

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

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 (i.e., the 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 (i.e., 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).

For the black tiger shrimp, between March 1995 and September 1995, the value of the option to exchange the 16-20 cpp non-par category for the par category is greater than the value of the option to exchange the par category for the 16-20 cpp non-par category. 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 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. 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.

Also for the black tiger shrimp, 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.

In the case of the white shrimp, and in particular, 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 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. 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 the deepest in-the-money option 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 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%.

4. PREDICTIVE ABILITY³

The shrimp futures market ability to unbiasedly predict spot prices for each size category is also evaluated in this paper. Monthly cash prices for par and non-par shrimp size categories (Urner-Barry Publications Inc., 1993-1998) are used for the analyses. Cash prices correspond to the prices at the end of the third Friday of the maturity month which is assumed to correspond to the last trading day allowed by the contracts. Futures prices, on the other hand, correspond to the futures prices 30 days before the last trading day allowed by the contracts. Before the analyses are carried out, the series are log transformed as in Antoniou and Foster (1994) and Pizzi, Economopoulos and O'Neill (1998). For this study, 35 and 34 monthly observations corresponding to the number of contracts traded between 1993 and August 1998 and 1994 and August 1998 for white and black tiger shrimps, respectively, are used. The data is checked for stationary using the Phillips-Perron test and it is concluded that all of them can be interpreted to have a unit-root.

The relationship between futures and cash prices in commodities is traditionally defined by

$$S_t = \beta_0 + \beta_1 F_{t-1} + \varepsilon_t \quad (5)$$

where S_t is the spot price in period t and F_{t-1} is the futures price at time $t-1$. Since the data is non-stationary a cointegration approach is used. The 30 day lag equation between spot and futures prices used for the test in equation (2) is chosen due to the fact that most of the trading activity in these contracts seems to take place a month before expiration. That period of greater activity should be interpreted as the period in which traders operate based on most representative expectations about the spot market at time of expiration. This is linked with the futures market efficiency, in the sense that a well behaved futures market should use all available information. Agent risk neutrality and a rational use of all available information are common assumptions underlying this model. Risk neutrality implies a zero risk premium, while the efficient impounding of all available, relevant information precludes unexploited arbitrage opportunities. If both parts of the above joint hypothesis are confirmed then the current futures price serves as an unbiased predictor of the future spot price. Acceptance of the joint hypothesis that both assumptions hold implies, therefore, that the futures markets demonstrate pricing efficiency. Rejection of one assumption, however, can lead to the rejection of the joint hypothesis, but need not necessarily imply market inefficiency. Rejection of the joint hypothesis, therefore, may suggest pricing inefficiency, risk aversion or both (Antoniou and Foster, 1994; Pizzi, Economopoulos and O'Neill, 1998). Given that we force

the assumption of risk neutrality, we limit the discussion to terms of futures market unbiasedness rather than efficiency. Since the variables involved show non-stationarity, cointegration techniques are used to estimate this relationship. In this paper, the Johansen method is followed because it allows for restriction tests, and it is believed to be more reliable (i.e., the Granger method tends to provide different answers depending on the variable placed on the left hand side of the cointegrating equation). Three tests are considered to be necessary to determine whether futures markets are unbiased predictors of spot prices. The first one states that spot and futures price series are cointegrated. Some papers assume that this is proof enough of an efficient long-term relationship between spot and futures prices (Harris, McInish, Shoesmith, and Wood, 1995). The second one is that in the cointegrating regression the intercept should be zero and cointegrating vector should be equal to one (i.e. $\beta_0 = 0$ and $\beta_1 = 1$). Other studies have assumed these two first conditions to be sufficient for market efficiency testing (Crowder and Hamed 1993; Lai and Lai, 1991). The third test for an efficient market determines whether the coefficients on futures first differences and the error correction term in the error correction model (ECM) are equal to one, and the coefficients on any lagged spot returns are zero. Antoniou and Foster (1994) suggest that while the first two conditions are necessary for efficiency, sufficiency would only be implied by showing that there are not important deviations from the long-run equilibrium in the short-term.

Trace tests for cointegration reject the existence of any long-term price relationship between the futures price and all size categories for both black tiger and white shrimps. Considering that the existence of such a long-term relationship is a necessary condition for market unbiasedness, the results indicate that shrimp futures markets seem not to be able to predict cash prices for any size category and shrimp type. Based on these results, there is no need to test for the above mentioned second and third conditions (it is not possible either, considering that the remaining two test depend on the existence of cointegrating vectors): the $\beta_0 = 0$ and $\beta_1 = 1$ joint restriction of the cointegrating equations; and that in the ECMs the coefficients on futures returns and the error correction term should be equal to one, and the coefficients on any lagged spot returns should be zero.

5. DISCUSSION

It has been shown that the two shrimp futures contracts can contribute very modestly to risk reduction by any of the hedging strategies studied.

Although the correlation coefficients between futures and cash prices of the size categories considered may seem

³ Martínez-Garmendia (2000) has a more extensive discussion on the topic.

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.

Fixed premiums/discounts seem not to be effective at eliminating cash market price differentials between the different deliverable grades. 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.

Also, our analyses show that the two shrimp contracts do not have ability to predict spot prices. In fact, the results suggest that cash and futures prices are not cointegrated for any size category. This result is not surprising considering the poor trading volume associated with these two futures contracts.

Liquidity problems contribute to both, lack of hedging effectiveness and poor predictive ability. 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 results suggest 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 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 paper, 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 paper, 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 towards 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.

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