Premiums/Discounts and Predictive Ability of the Shrimp Futures Market

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Seafood futures contracts are a novelty in the derivative markets, having shrimp as their only exponent. Unfortunately, shrimp futures contracts have suffered a disappointing start. The analyses focus on testing whether premiums/discounts for non-par deliverable shrimp size categories can eliminate cash price differentials, and whether the shrimp futures market can predict cash prices without bias. Results indicate ineffective premiums/discounts and predictive bias. These results and the momentous changes taking place in the seafood industry are contrasted to discuss the viability of seafood futures contracts.

The only seafood commodities currently traded in futures markets are frozen white and black tiger shrimps. The white shrimp contract trading opened in 1993, while the black tiger shrimp contract was introduced in 1994. These two contracts, on the Minneapolis Grain Exchange (MGE), have failed to attract the expected trade volume based on the underlying shrimp cash market flow. This has cast doubt regarding the potential of seafood products as a feasible underlying commodity for trade in futures markets. In this paper, we try to determine whether the premiums/discounts associated with non-par deliverable shrimp categories are able to eliminate the price differentials in their respective cash markets. The paper also focuses on the predictive ability of futures prices to forecast the spot prices of the various deliverable size categories. This is important because the effectiveness of futures markets in hedging risk is partly dependent on these issues. If futures markets are inefficient in the sense that they do not incorporate all relevant information and are biased predictors of spot prices, they will introduce extra cost to hedgers, namely the market failure cost (Antoniou and Foster 1994). We suggest that if poor contract design is to blame for the failure of shrimp futures contracts, seafood commodities, in general, could still be viable commodities for futures trading. In fact, recent developments in trading mechanisms, fisheries management, aquaculture production, and information availability in the seafood industry point towards a suitable environment for the establishment of seafood futures markets.

The two shrimp futures contracts include several deliverable varieties. Shrimp varieties are usually separated based on size, species, and origin. Par white shrimp includes the species *Penaeus vannamei, P. occidentalis*, and *P. stylirostris* from the western hemisphere, while the par black tiger shrimp is comprised of *P. monodon* from Thailand, the Philippines, and Indonesia.

In order to standardize the trade of shrimp within each contract, premiums and discounts have been introduced by the MGE for shrimp that deviate from par size categories and species (MGE 1993; 1997a; 1997b). 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. The different premiums determined by the MGE for each non-par size category used in the analyses are summarized in table 1. For the white shrimp futures contract, 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 2. Premiums and discounts have already changed twice for the white shrimp contract and once for the black tiger contract (tables 1 and 2).

Part of the explanation for the poor performance of the shrimp futures contracts may reside in high

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Table 1. Black Tiger Shrimp Futures Non-Par Size Category Delivery Premiums ($/lb) Implemented in the Minneapolis Grain Exchange

Size Category (cpp)	Dec 1994–Jul 1997	Starting Aug 1997
16–20	0.80	0.20
21–25	—	—
26–30	−0.60	−1.10

deliverable size category exchange option values, which stem from volatility in the price differentials between size categories (Martínez-Garmendia and Anderson 1999). In that study, a theoretical estimation of the value of the options to exchange par and non-par categories was carried out using the Black and Scholes formula. The results suggest that premiums/discounts are not able to eliminate the changing price differentials between all deliverable categories. However, a more intuitively direct method for testing whether premium/discounts are operating appropriately is to check whether the relationship between par and non-par category prices is one-to-one after adjusting for premiums/discounts. The shrimp futures market's ability to unbiasedly predict spot prices for each size category is also evaluated in this paper.

Data And Econometric Testing

Weekly cash prices for par and non-par shrimp size categories (Urner-Barry Publications Inc. 1993–1998) are used for the analyses. Cash prices for black tigers are from the Los Angeles market, while white shrimp cash prices are from the New York City market. These two locations are par delivery points determined by the MGE. Futures prices, however, correspond to closing quotes of the contract closest to expiration, until the last Friday before the expiration month. Cash and futures price series are log transformed before the analyses are carried out. For this study, 28 and 35 observations are used that correspond to the number of contracts traded from September 1993 to August 1998 and from December 1994 to August 1998 for white and black tiger shrimps, respectively. Figure 1 shows the price series for the time intervals studied.

Table 2. White Shrimp Futures Non-Par Size Category Delivery Premiums ($/lb) Implemented in the Minneapolis Grain Exchange

Size Category (cpp)	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
41–50	—	—	—
51–60	−0.50	−0.65	−0.90

The par size category for the black tiger shrimp futures contract is 21–25 cpp, while the non-par categories permitted for delivery are 16–20 and 26–30 cpp. All of them are *P. monodon* from Thailand, the Philippines, and Indonesia. For the white shrimp futures contract, the MGE accepts as par category 41–50 cpp and 31–35, 36–40, and 51–60 cpp shrimp as non-par categories. Par white shrimp include *P. vannamei, P. occidentalis*, and *P. stylirostris* from the western hemisphere. Prices for the different non-par sizes are adjusted by the corresponding premiums/discounts relative to the par size categories.

Some individual economic time series tend to be non-stationary and generally integrated of order one, *I(1)*. When a unit root is present in a time-series variable, it suggests that a shock in that variable has a sustained effect, while if it is stationary, the effect of the shocks tends to fade out through time (Rao 1994). This condition results in non-uniform variance of the disturbance term of the time series throughout the stretch for which data is available, which violates one of the five basic OLS assumptions. In this paper, determination of whether a variable is stationary or integrated of a certain order, *I(d)*, is carried out using the Phillips-Perron test. The null hypothesis of this test is that the variable is non-stationary.

The relationship between the par and non-par size categories after adjusting for exogenous premiums/discounts determined by the MGE can be expressed by

$$(1) \qquad S_t^{np} = \alpha_0 + \alpha_1 S_t^P + e_t$$

where S^{np} is the spot price for the non-par size category, and S^p is the spot price for the par category. Ideally, efficient premiums/discounts should lead to the joint parameter values restriction $\alpha_0 = 0$ and $\alpha_1 = 1$. Alternatively, the premiums/discounts of a contract may not be able to eliminate systematic arbitrage opportunities derived from price deviations between par and non-par categories. If that is the case, the above joint restriction would be statistically rejected. The variables associated with this relationship are checked for non-stationary behavior using the Phillips-Perron test. The z-statistics of the Phillips-Perron test at the levels and first differences are shown in table 3 for all price series. It is concluded that all of them can

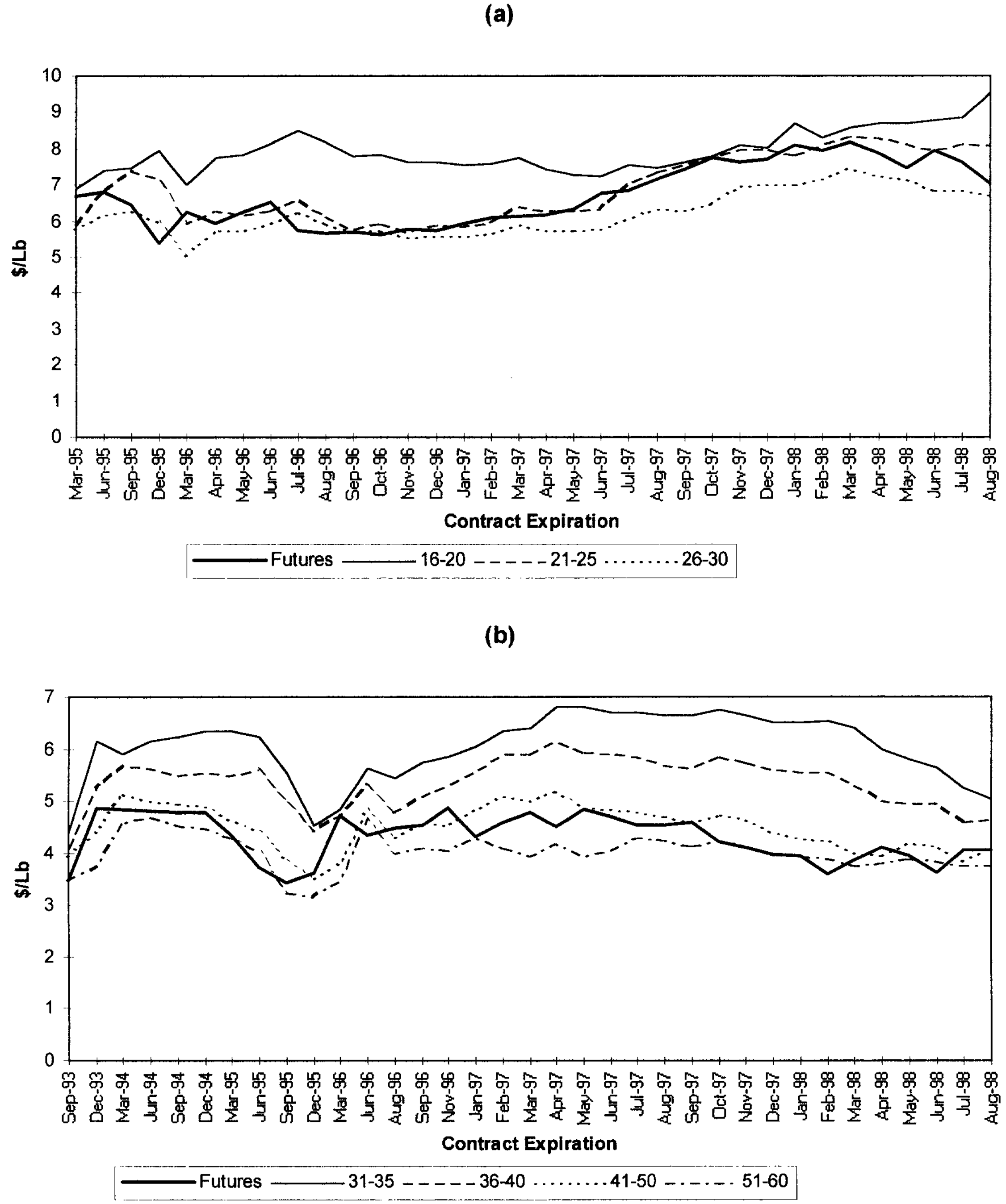

Figure 1. Futures Prices 30 Days Before and Spot Prices for the Black Tiger (a) and White Shrimp (b) Deliverable Categories.

be interpreted to have a unit-root. Since the variables involved show non-stationarity, cointegration techniques are used to estimate this relationship. In this paper, the Johansen (1988) 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). The restriction that $\alpha_0 = 0$ and $\alpha_1 = 1$ is tested using the Johansen test statistic, which is a likelihood ratio test that compares restricted and unrestricted estimations (Rao

Table 3. Phillips-Perron Test Statistics for Unit Roots Results and the Length of the Lags Used in the Model in Parenthesis

	Levels	Differences
Black tiger shrimp		
16–20 cpp	−1.1770	−6.0543[a](1)
21–25 cpp	−1.1644	−5.0504[a](1)
26–30 cpp	−1.2065	−5.0898[a](1)
futures	−1.0776	−7.2475[a](1)
White shrimp		
31–35 cpp	−1.7895	−3.5568[b](1)
36–40 cpp	−2.1766	−3.9474[a](1)
41–50 cpp	−2.3709	−4.0986[a](1)
51–60 cpp	−2.5013	−4.7178[a](1)
futures	−4.7178	−4.9061[a](1)

H_0: the series is I(1).
[a]Rejection at 1%
[b]Rejection at 5%

1994). The limiting distribution under the null hypothesis is Chi-square, with the number of degrees of freedom equal to the number of restrictions. This is two in our case. Cointegration between par and non-par size categories is tested using the Johansen cointegration procedure. Since Johansen's procedure is sensitive to the choice of length of the VAR model (Hall 1991), we need to determine the order of the model first. This is chosen according to the Akaike Information Criteria (AIC) statistic by testing up to 5 VAR orders.

The ability of the shrimp futures market to predict unbiased spot prices for each size category is also evaluated. The relationship between futures and cash prices in commodities is traditionally defined by

$$S_t = \beta_0 + \beta_1 F_{t-n} + \varepsilon_t \qquad (2)$$

where S_t is the spot price in period t and F_{t-n} is the futures price at time t-n (for n = 1, 2, 3, 4, 5, 6 and 7 weeks). Since we do not *a priori* know the period in which traders operate based on most representative expectations about the spot market at the time of expiration, a wide range was chosen for testing. These tests are linked to the concept of futures market efficiency, in 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 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 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 lack of futures market bias rather than efficiency. Three tests are considered 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 is that in the cointegrating regression the intercept should be zero and the 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 no important deviations from the long-run equilibrium in the short-term.

Results

The results associated with equation (1) for both black tiger and white shrimps are summarized in table 4. The number of cointegrating vectors is determined using the trace test and the critical values provided by Pesaran, Shin, and Smith (1996). The tests suggest that cash prices of 16–20 and 26–30 cpp black tiger shrimp size categories are cointegrated with the 21–25 cpp par category. In the case of the white shrimp, while the 36–40 cpp non-par category presents one cointegrating vector with the 41–50 cpp par size category, the trace test cannot reject the existence of zero cointegrating vectors between the rest of the non-par size categories and the par size category. The $\alpha_0 = 0$ and $\alpha_1 = 1$ joint restriction test on the cointegrating vector between the 36–40 cpp non-par category and the par category, however, is rejected.

Cointegrating regressions for cash and futures prices are also carried out to determine whether

Table 4. Trace Tests Statistics with the VAR Order in Parentheses, Estimated Parameter Values, And Restriction Tests for Equation (1)

	Trace Test[a]		Parameter Values		Restriction
	$r = 1$	AIC	α_0	α_1	$\alpha_0 = 0, \alpha_1 = 1$
Black tiger shrimp					
16–20 cpp	12.5602(1)[b]	115.0595	—	—	—
26–30 cpp	8.3126(1)[b]	134.2395	—	—	—
White shrimp					
31–35 cpp	18.1335(3)[c]	96.0322	—	—	—
36–40 cpp	8.1934(1)	108.4122	0.4378	0.81465	25.9720[.000]
51–60 cpp	14.3240(1)[b]	95.6407	—	—	—

[a]H_0: at least r cointegrating vectors
[b]Rejection at 5%
[c]Rejection at 10%

futures prices are reliable predictors of cash prices. For black tiger shrimp (table 5), trace tests for cointegration reject the existence of any long-term price relationship between the futures price and all size categories, with the exception of lags 1 and 7 for the par size category 21–25 cpp. Although a cointegrating vector is found for these two cases, the $\beta_0 = 0$ and $\beta_1 = 1$ joint restriction of the cointegrating equations tested does not hold. With regard to white shrimp (table 6), four combinations of lags and size categories are found to have cointegrating relationships between cash and futures

Table 5. Trace Tests Statistics with the VAR Order in Parentheses, Estimated Parameter Values, and Chi-squared Restriction Tests (with Significance Level in Brackets) in Equation (1) for Black Tiger Shrimp

	Trace Test[a] $r=1$	AIC	β_0	β_1	$\chi^2(2)$
f_{t-7}					
16–20 cpp	12.3007(1)[b]	90.8455			
21–25 cpp	1.6001(1)[b]	115.2127	−0.26564	1.1654	11.3031[.004]
26–30 cpp	13.0617(2)[b]	125.8804			
f_{t-6}					
16–20 cpp	10.6303(1)[b]	106.5377			
21–25 cpp	12.2412(2)[b]	121.5527			
26–30 cpp	9.701(2)[b]	124.406			
f_{t-5}					
16–20 cpp	12.4575(2)[b]	102.9746			
21–25 cpp	13.3564(2)[b]	125.5057			
26–30 cpp	7.3486(3)[b]	127.8629			
f_{t-4}					
16–20 cpp	10.2327(1)[b]	108.3298			
21–25 cpp	16.9158(1)[b]	123.3359			
26–30 cpp	9.8943(1)[b]	128.2088			
f_{t-3}					
16–20 cpp	11.783(1)[b]	103.3873			
21–25 cpp	12.5086(1)[b]	120.7009			
26–30 cpp	11.8974(1)[b]	123.6406			
f_{t-2}					
16–20 cpp	12.2783(1)[b]	105.5589			
21–25 cpp	14.7389(1)[b]	123.0519			
26–30 cpp	9.7372(1)[b]	124.6958			
f_{t-1}					
16–20 cpp	12.9366(1)[b]	107.661			
21–25 cpp	2.353(1)	123.5786	−0.068358	1.0583	17.4336[.000]
26–30 cpp	12.3561(1)[b]	126.2253			

[a]H_0: at least r cointegrating vectors
[b]Rejection at 5%

Table 6. Trace Tests Statistics with the VAR Order in Parentheses, Estimated Parameter Values, and Chi-squared Restriction Tests (with Significance Level in Brackets) in Equation (1) for White Shrimp

	Trace Test[a] r = 1	AIC	β_0	β_1	$\chi^2(2)$
f_{t-7}					
31–35 cpp	14.818(5)[b]	61.9728			
36–40 cpp	1.707(5)	80.84	−0.12711	1.2264	20.6643[.000]
41–50 cpp	17.3583(5)[b]	87.1052			
51–60 cpp	13.1913(5)[b]	63.2698			
f_{t-6}					
31–35 cpp	14.7814(3)[b]	60.2231			
36–40 cpp	12.0771(3)[b]	73.4646			
41–50 cpp	14.0293(5)[b]	79.0763			
51–60 cpp	15.7163(5)[b]	57.6232			
f_{t-5}					
31–35 cpp	19.4223(2)[b]	58.088			
36–40 cpp	16.8344(5)[b]	72.4049			
41–50 cpp	17.7219(5)[b]	74.9258			
51–60 cpp	12.0561(3)[b]	56.0643			
f_{t-4}					
31–35 cpp	13.1281(3)[c]	61.3565			
36–40 cpp	17.9454(5)[b]	79.3719			
41–50 cpp	19.3315(5)[b]	76.5534			
51–60 cpp	20.0262(2)[b]	59.9734			
f_{t-3}					
31–35 cpp	7.7325(5)	78.2626	−0.21074	1.35	17.8374[.000]
36–40 cpp	14.3963(5)[b]	74.3214			
41–50 cpp	18.7085(5)[c]	75.5991			
51–60 cpp	1.6787(4)	58.8878	2.4101	−0.60811	18.5203[.000]
f_{t-2}					
31–35 cpp	11.8877(3)[b]	60.6925			
36–40 cpp	4.718(2)	71.8868	−3.0055	3.2179	17.6992[.000]
41–50 cpp	12.9519(5)[b]	83.5824			
51–60 cpp	13.4918(1)[b]	61.8261			
f_{t-1}					
31–35 cpp	12.8692(5)[b]	54.4225			
36–40 cpp	18.6484(2)[c]	64.7082			
41–50 cpp	15.8784(5)[b]	81.3137			
51–60 cpp	14.1863(1)[b]	60.9107			

[a]H_0: at least r cointegrating vectors
[b]Rejection at 5%
[c]Rejection at 10%

prices. These are 36–40 cpp for 7 lags, 31–35 and 51–60 cpp for 3 lags, and 36–40 cpp for 2 lags. However, the $\beta_0 = 0$ and $\beta_1 = 1$ joint restrictions tested on these cointegrating equations do not lead to chi-squared statistics that deem the null hypothesis acceptable, as it was the case for the black tiger shrimp.

The results indicate that shrimp futures markets seem not to be able to predict cash prices for any lag, size category, and shrimp type. Based on these results, there is no need to test for the two other necessary conditions—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.

Conclusions

This paper tests the appropriateness of the use of fixed premium/discounts in the black tiger and white shrimp futures contracts. It also attempts to test the futures market's predictive ability. The results suggests that both tests lead to a negative answer. However, even if these two contracts seem not to be meeting expectations, it cannot be presumed that shrimp, and, by extension, other seafood commodities, are inherently unfeasible for futures market trading.

Cash prices of non-par deliverable shrimp size categories for both contracts are tested for cointegration with their respective par size category on a pair-wise basis. Although in one case the prices for non-par 36–40 cpp non-par and 41–50 cpp deliverable size categories seem to have a long-term relationship, the restriction test suggests that premiums/discounts cannot eliminate opportunities for arbitrage. Based on these results, the exchange should consider a floating rather than fixed premium/discount system to homogenize the prices of the different shrimp size categories included in the contracts.

The second task of this paper is to determine whether futures prices can unbiasedly predict cash prices. Our analyses show that such is not the case for either shrimp futures contract. None of the tested lag times presents a consistent correlation between futures and cash prices. This result is not surprising considering the poor trading volume associated with these two contracts through-out the entire trading periods.

This paper demonstrates the lack of effectiveness of premiums/discounts to eliminate cash price differentials, and therefore, arbitrage opportunities. At the initial stages of the contracts, these arbitrage opportunities may have discouraged many traders in two possible ways. First, traders expecting deliveries probably received several non-par size categories. Also, the existence of short-term arbitrage opportunities within a futures contract usually results in loss of hedging effectiveness of the contract. Therefore, even traders who offset their positions before delivery did not see the potential benefits of futures contracts to manage risk. This early loss of interest in the contracts produced poor trade volume, which explains the poor predictive ability of the contracts.

The lack of success of the two shrimp contracts could persuade exchanges not to offer more futures contracts for seafood products in the future. Unfortunately, this industry could benefit from market-based risk management mechanisms such as derivative markets. The seafood economy worldwide is highly regulated by governmental fishery resource management, and in some countries by price support systems and trade barriers. The existence of successful seafood futures contracts could help liberalize markets and improve the ability of the industry to manage risk. We believe that a greater homogeneity of seafood products could, in fact, lead to successful seafood futures contracts. The increasing relevance of aquaculture as a controlled production system relative to more uncertain supply from wild captures could eventually become a critical, positive factor for the success of seafood futures contracts.

The other major challenge for seafood futures contracts is that seafood cash markets are characterized by a significant lack of transparency. This is also bound to change due to the opening of websites specialized in electronic seafood trading. Public bids/asks on a global and continuous scale could become a big step towards greater seafood spot market transparency.

Finally, details on seafood production are rarely unveiled by timely data on landings or expected crops. This is relevant information that will influence future cash prices and current futures prices. In its absence, however, it cannot be efficiently incorporated by traders into their decisions to buy and sell futures contracts. Timely governmental and private reports on production and market outlook could help to create expectations that can be channeled into futures price formation. In fact, a greater number of sources and more sophisticated analyses are becoming available, especially since the inception of internet-based electronic markets.

Therefore, although seafood futures markets have had a discouraging start with the shrimp futures contracts on the MGE, there are signs for optimism. The advent of aquaculture and the internet could revolutionize the way seafood is traded. As a result, the seafood industry is evolving towards product and information supply, as well as spot market characteristics favorable for futures contract trading.

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