The Hedging Performance in New Agricultural Futures Markets: A Note

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Agribusiness companies and farmers must cope with the risk of price changes when buying or selling agricultural commodities. Hedging price risk with agricultural commodity futures offers a way of minimizing this risk. Information is needed on the hedging effectiveness of these futures. Because many new agricultural futures markets, especially those in Europe, are thin markets, hedgers face liquidity risks which have to be taken into account when evaluating hedging effectiveness. © 1997 John Wiley & Sons, Inc.

Introduction

Price risk has become a more immediate issue for both farmers and agribusiness companies in the United States and European Union (EU) due to GATT free trade policies and the agricultural policy reforms made by the EU. Owing to increased agricultural price fluctuations, some exchanges in Europe, such as the Amsterdam Agricultural Futures Exchange, the London Commodity Exchange, the Waren Termin Börse in Hannover, and the Warsaw Board of Trade, are planning to introduce new agricultural futures contracts. Recently the Marché à Terme International de France in Paris and the Amsterdam Agricultural Futures Exchange have introduced rapeseed futures contracts and wheat futures contracts, respectively. These new futures markets are thin, meaning that the size of the transaction of an individual hedger may have a significant effect on the price and may therefore result in substantial "transaction costs."[1,2] These transaction costs are the premiums that hedgers are forced to pay or the discounts they are forced to accept in order to establish or close-out futures positions.[3]

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A futures market is considered liquid if traders and participants can buy or sell futures contracts quickly with little price effect as a consequence of their transactions. However, in thin markets, transactions of individual hedgers may have significant price effects and can affect the hedging effectiveness.[4] In recent articles Conley[5] and Ennew et al.[6] draw conclusions about the hedging performance of a futures market without recognizing this price effect. This article proposes a new method to measure hedging effectiveness which also considers how the taking and unwinding of a large position may affect the futures price in thin futures markets. Therefore, the proposed measure is particularly appropriate for thin markets, such as some of the European agricultural futures markets. The proposed measure also includes basis risk and trading costs. These have been discussed in previous research.

Literature Review

Recently proposed measures of hedging effectiveness express the usefulness of trading a futures contract, based on the results of a combined cash-futures portfolio relative to the cash position alone.[7–18] The researchers' conclusions about the hedging performance of futures markets depend on the method used to measure the hedging effectiveness.[5,6] The most frequently used measures are analyzed below.

Ederington[7] and Hill and Schneeweis[9] measured hedging effectiveness as the percentage reduction in the variance of returns achieved by an optimally hedged position as opposed to an unhedged position. Their hedging effectiveness measures assume a hedging strategy to minimize price variance. The objective of these effectiveness measures is to measure hedging effectiveness for a risk-minimizing hedge which can be represented by the minimum risk hedging ratio.

In Table I the hedging performance measures frequently cited are summarized and classified according to their salient features.[4] This list is by no means exhaustive.

All these measures do not take the liquidity risk involved in trading futures into consideration explicitly. However, thin agricultural futures markets do introduce liquidity risk which will have an impact on the variance of returns.

Liquidity risk is the risk the hedger faces if there is a sudden rise or fall in prices due to order imbalances. This risk seems important to systematic hedgers, particularly in thin markets. Sudden price changes can occur where both long and short hedges are concerned. If a relatively small market sell (buy) order arrives, the transaction price will be the bid (ask) price. For a relatively large market sell (buy) order, several transaction prices are pos-

Table 1. Frequently Used Hedging Effectiveness Measures and Their Characteristics.

Measure	Based on Minimum Variance Hedge	Based on Risk-Return	Including Cost Involved in Futures Trading[a]	Including Liquidity Risk
Ederington	Yes	No	No	No
Overdahl and Starleaf	Yes	No	No	No
Howard and D'Antonio	No	Yes	No	No
Hsin, Kuo, and Lee	No	Yes	No	No
Gjerde I	No	No	Yes	No
Gjerde II	Yes	Yes	Yes	No
Chang and Fang	No	Yes	No	No

[a] Brokerage costs and margin requirements.

sible, at lower and lower (higher and higher) prices, depending on the size of the order and the number of traders available. If the sell order is large, the price should keep falling to attract additional traders to take the other side of the order. In a deep market, given a constant equilibrium price, relatively large market orders result in a smaller divergence of transaction prices from the underlying equilibrium price than in a thin market. According to Lippman and McCall[19] the deepness of the market for a commodity increases with the frequency of offers.

The degree of liquidity in a market is a key aspect of futures market performance. Some exchanges monitor temporary order imbalances i.e. liquidity risk, and slow down the trade process if these are present. For example, an order book official issues warning quotas when trade execution results in price changes that are larger than prescribed by the exchange, and halts trading when order execution would result in price changes that exceed exchange-mandated maximums.[20, 29]

Note that liquidity risk is dependent on the basis at time of lifting. An example makes this clear. Suppose a potato producer goes short the April 1996 contract traded at the Amsterdam Agricultural Futures Exchange at 30 Dutch Guilders. Further suppose that in April 1996 when (s)he enters the market to lift his/her hedge the current basis is 0.5 Dutch Guilders. (S)He will buy to cover his/her short position and because of a lack of liquidity the transaction will push the price upward, so that his/her actually realized basis is 0.1 Dutch Guilders. Thus, the liquidity risk has actually improved the hedging effectiveness. The hedging effectiveness measure proposed in this article will account for this interaction between basis risk and liquidity risk.

A New Measured of Hedging Effectiveness

Following the method of Ederington[7] let R represent the return on a portfolio which includes both spot market holdings, X_s, and futures market holding, X_f, where X_s and X_f have opposite signs. A hedger who uses the futures market to manage his/her price risk and is aware of the basis and liquidity cost will take this into account. The expected return on a portfolio can now be written as

$$E(R) = X_s E[P_s^2 - P_s^1] + X_f E[P_f^2 - P_f^1] - X_f E[LC] - K(X_f) \quad (1)$$

The variance of the return is given by

$$VAR(R) = X_s^2\sigma_s^2 + X_f^2\sigma_f^2 + X_f^2\sigma_{LC}^2 + 2X_sX_f\sigma_{sf} - 2X_sX_f\sigma_{sLC} - 2X_f^2\sigma_{fLC} \quad (2)$$

Where $E(R)$ is the expected return on a portfolio, $[P_s^2 - P_s^1]$ is the gain or loss on a spot position. $[P_f^2 - P_f^1]$ is the gain or loss on the futures position, LC are the liquidity costs, $K(X_f)$ are the brokerage costs and the cost of providing margin. σ_s^2, σ_f^2, σ_{sf}, σ_{fLC}, and σ_{sLC} represent the subjective variances and the covariances of the possible price and liquidity cost changes from Time 1 to Time 2.

Let $b = -X_f/X_s$ represent the proportion of the spot position hedged. Since in a hedge X_s and X_f have opposite signs, b is usually positive. The variance can now be expressed as:

$$VAR(R) = X_s^2[\sigma_s^2 + b^2\sigma_f^2 + b^2\sigma_{LC}^2 - 2b\sigma_{sf} + 2b\sigma_{sLC} - 2b^2\sigma_{fLC}] \quad (3)$$

Holding X_s constant, let us consider the effect of a change in b, the proportion hedged, on the expected return and variance of the return R.

$$\frac{\delta\, VAR(R)}{\delta b} = X_s^2[2b\sigma_f^2 + 2b\sigma_{LC}^2 - 2\sigma_{sf} + 2\sigma_{sLC} - 4b\sigma_{fLC}] \quad (4)$$

So the risk minimizing b, b^* is

$$b^* = \frac{\sigma_{sf} - \sigma_{sLC}}{\sigma_f^2 + \sigma_{LC}^2 - 2\sigma_{fLC}} \quad (5)$$

Substituting (5) in (3) yields

$$VAR(R^*) = X_s^2 b^{*2}(\sigma_f^2 + \sigma_{LC}^2 - 2\sigma_{fLC}) + X_s^2 b^*(-2\sigma_{sf} + 2\sigma_{sLC}) + X_s^2\sigma_s^2 \quad (6)$$

where $VAR(R^*)$ denotes the minimum variance on a portfolio containing futures.

Let U represent the return on an unhedged position,

$$E(U) = X_s E[P_s^2 - P_s^1] \quad (7)$$

$$VAR(U) = X_s^2 \sigma_s^2 \tag{8}$$

In line with Ederington[7] our measure of hedging effectiveness is the percentage reduction in the variance of the return on the portfolio and can be given by

$$HE = 1 - \frac{VAR(R^*)}{VAR(U)} \tag{9}$$

Consequently,

$$HE = -\frac{b^{*2}(\sigma_f^2 + \sigma_{LC}^2 - 2\sigma_{fLC}) + b^*(-2\sigma_{sf} + 2\sigma_{sLC})}{\sigma_s^2} \tag{10}$$

It can easily be shown that in liquid markets, i.e. markets with no liquidity risk, the proposed measure HE equals the Ederington measure.

Our measure will be a particularly valuable tool in evaluating the hedging effectiveness of new agricultural futures which will, initially, be traded in thin markets. In order to illustrate the usefulness of the proposed measure and the difference between this measure and the Ederington measure (the latter is widely used by practitioners and researchers), we have applied both hedging effectiveness measures to data from the Amsterdam Agricultural Futures Exchange.

Data

The Ederington measure and the proposed measure are calculated using data on the potato futures contract traded at the Amsterdam Agricultural Futures Exchange. The annual volume (200,000 contracts in 1995) is small compared with agricultural futures traded in the United States. The sample covers the period from September 1995 up to April 1996. This period equals one potato storage year, i.e. potatoes harvested in 1995. The transaction-specific futures contracts data were obtained from the Clearing Corporation (NLKKAS) of the Amsterdam Agricultural Futures Exchange. The cash price data were obtained from the Rotterdam potato cash market. This is the central spot market for potatoes in the Netherlands.

The transaction-specific data consist of the price quoted of every futures contract traded in chronological order. Liquidity costs can be calculated using these data. In the case of an order selling imbalance liquidity costs were calculated as the area between the downward-sloping price path and the price for which the hedger enters the futures market, hence,

$$LC = PF^1 * N - \sum_{i=1}^{N} (PF^i) \tag{11}$$

where PF^1 is the futures prices for which the hedger enters the market, PF^i is the price of the ith futures contract and N the total order flow.

The liquidity costs in the case of an order buying imbalance were calculated as the area between the upward-sloping price path and the price for which the hedger enters the futures market, hence,[4]

$$LC = \sum_{i=1}^{N} (PF^i) - PF^1 * N \tag{12}$$

Having determined the liquidity costs, the spot prices and the closing prices of the futures contract, the proposed measure can be calculated according to equation (10). The study tests the hedging performance of hedges held over one week, hence $P_s^2 - P_s^1$ in equation (1) covers one week.

We hypothesize that the proposed measure shows a relatively less effective hedge than the Ederington measure because the latter does not include liquidity risk.

Results

Table II tabulates the value of the hedging performance measured by the Ederington measure, the value of the proposed measure, the variances and covariances of the spot price, futures price, and liquidity risk respectively.

Note that both measures range from 0 to 1, indicating the reduction in the variance of the return. From Table II, it appears that the hedging effectiveness of the potato futures contract is higher according to the Ederington measure than according to the proposed measure, which corresponds with our expectations. This result is due to the fact that the

Table 2. Hedging Performance of Potato Futures Contract Delivery April 1996.

Ederington Measure	Proposed Measure
0.94	0.89
$b^* = 0.47$	$b^* = 0.44$

proposed measure takes basis risk and liquidity risk into account, whereas the Ederington measure only takes basis risk into account.

To see whether the hedging effectiveness using the Ederington measure is statistically different from the proposed measure, we test the hypothesis H_0: $\{VAR(R^*) = VAR(R^*)^e\}$ where $VAR(R^*)$ and $VAR(R^*)^e$ denotes the minimum variance on a portfolio containing futures based on the proposed measure and the Ederington measure respectively. We expect that $VAR(R^*) > VAR(R^*)^e$ because, in our approach, we take liquidity risk into consideration. To make this test we calculate $F = VAR(R^*)/VAR(R^*)^e = 1.83$ with 116 df. Under H_0 the 5% level is $F_{0.05} = 1.36$. Hence, H_0 is rejected ($p = .00063$), meaning that the minimum variance on a portfolio containing futures is significantly greater for our approach than the Ederington approach. Therefore, the inclusion of liquidity risk makes our measure of hedging effectiveness statistically significant different from the Ederington measure.

Table II shows that the Ederington measure recommends hedging 47% ($b^* = 0.47$) of the spot position whereas the proposed measure recommends hedging 44%. Our empirical application illustrates that in thin markets, the Ederington measure may overestimate hedging effectiveness and therefore recommends hedging more than in the case that liquidity risk is taken into account. Therefore, we propose to use the hedging effectiveness measure as it is given in equation (10), if we suspect the futures market is thin.

Conclusions

Unlike other studies on the measurement of futures contract performance we emphasize that futures markets not only introduce basis risk but also liquidity risk. This is particularly relevant in thin markets such as the present European agricultural futures markets. We propose a more general measure than the Ederington measure by including liquidity risk. If there is no liquidity risk, our measure equals the Ederington measure. So, whenever we suspect that the futures market is thin because, for example, the volume traded is small or the fact that there are no scalpers on the floor to absorb temporary order imbalances, we recommend using the proposed hedging effectiveness measure. The application of this measure requires transaction-specific data and cash market data. Because of the evolution of information technology these data become easy to obtain. Therefore, it seems that our measure can be useful in managing the futures exchange and to assist agribusiness companies in evaluating the performance of futures contracts in order to minimize risk.

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