The Significance of Hedging Capital Requirements

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INTRODUCTION

The effects of capital requirements are usually not considered in evaluations of hedging strategies despite evidence that those effects may be significant. Most analysts have ignored initial margin, marking-to-market,[1] and transaction costs requirements of hedgers. For example, Peterson and Leuthold (1987) exclude margin call effects from their analysis of cattle hedging strategies, describing them as trivial. Yet, Kenyon and Clay (1987) find margin effects to be significant when hedging hogs due to the capital liquidity problems they can create for producers. Also, in financial markets, Chang and Loo (1987) find that the marking-to-market feature of futures trading alters some price relationships.

The debate over capital requirement effects centers on two questions: (1) the amount of capital needed to meet a futures hedger's desired probability level of covering all marking-to-market and transaction cost requirements; and (2) whether that capital amount is large enough to affect hedging behavior. Analysts who have ignored capital requirements of hedgers implicitly assume there is no need to consider their size because there are no impediments to capital availability or no significant costs associated with using capital for futures hedging. However, Schmiesing et al. (1985) show that access to funds and interest rates paid vary among individual firms. Also, it is expected that transactions costs associated with different hedging strategies will vary also. This means that costs could be significant for some firms, as argued by Kenyon and Clay (1987) and Berck (1981). The first step in clarifying this debate is found in Blank (1990), who presents a model for determining the size of hedging capital requirements. In this note, capital requirements and associated transaction costs are estimated for a cross section of products, and evaluated in terms of their significance for a hedging program by using a new test outlined here.

CAPITAL REQUIREMENTS

Determining the amount of hedging capital required is an empirical process; there is no general theory to guide the effort (Hill et al., 1983). Kolb, Gay, and Hunter

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[1]"Marking-to-market" or "daily resettlement" is the process used by futures exchanges to adjust account balances at the end of each trading day to insure market liquidity. All losses incurred must be met by a cash payment, even if the position remains open. Any profits accrued in futures positions may be used to cover losses, and surplus profits can be withdrawn in cash if desired.

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(1985) argue that, for any size hedging account, there is some probability that losses will deplete it of sufficient funds required to continue futures trading. Blank (1990) shows that the amount of capital needed is the greater of short- and long-term requirements, with each estimated from historical data. The minimum amounts of hedging capital needed to operate, respectively, in the very short-term, and long term are defined by Blank (1990) as:

$$H_s^* = M^* + \left[\sum_{f=1}^{i} N_{sf} L_f\right] - \left[\sum_{f=c=1}^{i} \Gamma_c r_{cf} |N_{sf} L_f|\right] \quad (1)$$

and

$$H_k^* \geq M^* + \sum_{f=1}^{i} (|D_f| - \pi_f) - \left[\sum_{c=1}^{i} \Gamma_c (\pi_c - |D_c|)\right] \quad (2)$$

where H_s^* is the capital which is required during a short-term losing streak in each of i futures markets; H_k^* is the long-term hedging capital required to operate in futures (f) and cash (c) markets for i different products; M^* is the maximum of the sum of maintenance margins[2] per contract for all futures positions held open simultaneously at any point during the time period under consideration; N_s is the number of days in the losing streak; L is the average amount lost on each unprofitable day; Γ_c is a short-term liquidity factor ($0 \leq \Gamma \leq 1$) for each cash market (defined as the portion of the cash position which a hedger is willing and able to liquidate within the time requirements to meet a margin call); π is the total value of all profitable days; D is the total loss from all unprofitable days; and r_{cf} is the correlation coefficient describing the relationship between price changes in the relevant cash and futures markets.

Capital requirements for a hedging program simulated using daily data from 1986–1990 are presented in Table I. The first column of Table I contains estimates of margin and reserve capital requirements per futures contract calculated using the equations, as explained by Blank (1990). The amount of sufficient hedging capital is inversely related to the degree of liquidity of the cash product. Cash product liquidity, Γ, in eqs. (1) and (2), is assumed to be zero in this study to give maximum estimates of capital requirements to facilitate testing the significance of the range's high end.[3] Hedging transaction costs, associated with the estimated margin capital requirements per futures contract, include commissions and interest expense. Commissions paid to futures brokers by a hedger depend on the number of transactions made during a time period. In this analysis, a "maximum" amount is estimated by assuming a selective hedging program is used, which causes the hedger to make a futures trade each time a margin call is received.[4] The resulting average number of round turn transactions per year are multiplied by the commission per contract (assumed to be $50) for each product. The second column of Table I lists the simulated commission totals. Interest expense per year is calculated simply by multiply-

[2]Maintenance margin is the minimum amount of capital which must be on deposit with a futures exchange to keep a futures position open. The minimum level per futures contract is set by exchanges, but brokers may require higher amounts (Edwards and Neftci, 1988).

[3]Obviously, if the maximum requirements are not "significant," then neither are lesser amounts. If the maximum is significant, an analyst may wish to test the effects of Γ values greater than zero.

[4]Any time price changes lower a hedger's equity below the maintenance margin level a margin call is issued. In the system used here, the hedger would liquidate the futures position rather than meet the margin call with additional capital.

Table I
CAPITAL REQUIREMENTS (PER CONTRACT) FOR SELECTIVE HEDGING

Product	Margin Amount ($)	Annual Commission ($)	Annual Interest ($)	Annual Total ($)	As % of Margin (%)	As % of Value (%)
Cattle	1,490	1,100	245	2,835	283	9
Hogs	3,600	1,000	492	5,092	509	34
Soybeans	3,346	1,400	486	5,232	523	17
Corn	1,156	1,600	235	2,991	598	24
Crude oil	5,502	1,250	735	7,487	374	37
Gold	6,712	950	862	8,524	341	22
S&P 500	22,511	1,150	2,770	26,431	264	16
T-bonds	7,135	800	904	8,839	295	9
Yen	6,138	1,100	803	8,041	365	9

ing the capital requirements plus half the annual commissions[5] by the annual interest rate paid by hedgers. The results are in the third column of Table I. These two types of transaction costs are added to margin deposit estimates to get the total hedging capital requirements per year, presented in the fourth column of Table I.

SIGNIFICANCE OF CAPITAL REQUIREMENTS

Something is "significant" if it is considered during decision making. In this article, "significance" is defined to mean that the trader alters the actual size of his futures market position due to capital requirements. Clearly, hedgers with different levels of wealth may make different judgments concerning the significance of particular absolute amounts of required capital. However, the specific trading behavior that such judgments produce cannot be identified in many cases.[6] Therefore, the absolute amounts of capital involved may give a qualitative indication of possible hedger reaction, but a quantitative assessment of trading behavior free of wealth effects is necessary to test the real "significance" of capital requirements.

The last two columns in Table I present measures of the relative size of capital requirements for a cross section of products. First, total annual requirements are expressed as a percentage of the initial margin requirements[7] for each product. For the sample of products, the total capital requirements range from 283–598% of initial requirements. This means that over a year of operation hedgers may need nearly *six times* as much capital as their broker demands initially. Second, total capital requirements can become a sizeable percentage of a futures contract's total value, as shown in the last column of Table I. For example, live hogs and crude oil would each have required selective hedgers to pay out over one third of the value of their hedge positions in the simulation reported in Table I. Clearly, this is a relatively large amount of capital, and a requirement which some hedgers may not have been able to meet.

The results in Table I strongly suggest that hedging capital requirements can be significant in absolute size. However, without information concerning a person's access to capital, these results are not sufficient to prove that a hedger's trading behavior is effected. Therefore, a specific test of capital requirement significance is developed below, based on trading behavior effects. The general test measures whether a hedger's trading position changes in size due to capital requirements, without regard for that person's access to capital, balance sheet constraints, or sources of income.

After reviewing the theoretical and empirical shortcomings of previous studies, Blank, Carter, and Schmiesing (1991, p. 374) conclude that "... risk-adjusted *profits* (utility) are the primary goal of traders and, therefore, provide the incentive for market actions taken." The focus of hedging strategies is on identifying the optimal hedge ratio and maintaining futures market positions which reflect that relationship, defined as the ratio of quantities hedged (X) divided by quantities held in the cash market (K). Therefore, a test of whether capital requirements affect trading behavior can be based on whether the optimal hedge is reduced by the inclusion of

[5]Taking half of the total annual commissions to calculate interest expense assumes that trades are made at even time intervals across the year. A 12% interest rate is used.

[6]For producers with relatively low wealth, capital requirements may prevent them from hedging. This does not indicate anything about how producers judge the costs/benefits of heding, it could be simply a function of capital (un)availability.

[7]The initial margin amounts used are averages of actual requirements by brokers during 1990.

trading costs. The utility-maximizing hedge ratio (for a "short" hedger), as expressed by Witt, Schroeder, and Hayenga (1987) and others, is modified here by the addition of a capital requirements factor (C) to give:

$$\frac{X}{K} = \frac{\sigma_{cf}}{\sigma_f^2} + \frac{FP_t - E(FP_{t+i}) - C}{K\mu\sigma_f^2} \tag{3}$$

where σ_f^2 is the variance in futures market prices; σ_{cf} is the covariance between cash and futures prices; FP_t is the futures price at time t; and μ is a risk aversion parameter, which is positive for risk-averse hedgers.

By adding a capital requirements factor to the "speculative" component of the hedge ratio formula, those requirements can be assessed as to their direct effects on hedging behavior. Normally, the risk-minimizing "hedging" component of the equation, σ_{cf}/σ_f^2, is adjusted by only a hedger's expected futures gross profit, $FP_t - E(FP_{t+i})$, adjusted for risk aversion. Subtracting capital costs changes gross profits into net profits, which is more relevant to decision-makers. By taking gross profit expectations as given, and expressing C as requirements per unit (which makes $K = 1$), the remaining portion of the speculative component of eq. (3) becomes

$$\Delta\frac{X}{K} = \frac{-C}{\mu\sigma_f^2} \tag{4}$$

which is the amount that the optimal hedge ratio is reduced due to capital requirements, *ceteris paribus*.[8]

The test of significance simply involves calculating the effects of capital requirements on the hedge ratio using eq. (4). If the incremental change recommended in the optimal hedge ratio is smaller than the size of a contract which can be traded, the hedger would not change his futures market position and, therefore, the capital requirement is judged to be insignificant in its effect on hedging behavior. For example, a crude oil refiner holding an average inventory of 10,000 barrels and a hedge position of 90%, who calculates that a 10% reduction in the hedge ratio is needed to account for capital requirements, could make such an adjustment by holding one less futures contract (which equals 1000 barrels). On the other hand, if the hedge ratio reduction needed is calculated to be only 2%, the firm could not adjust its hedge position that finely (given the contract size) and, therefore, would make no changes due to capital effects.

From eq. (4) it is clear that each hedger will respond differently to capital requirements, depending on that person's degree of risk aversion. As risk aversion (μ) increases, a person's sensitivity to the costs of the price protection offered by hedging decreases. For less risk-averse hedgers, the response to hedging transaction costs increases as those hedgers become increasingly concerned about the reduction in utility caused by these costs. This somewhat surprising result may help explain the existence of selective hedging strategies. For hedgers who are not highly risk averse (they have a low μ), the optimal hedge ratio will change significantly with changes in price expectations, variance in prices, and trading costs (all of which affect C).

[8]Both trading costs (interest and brokerage fees) and capital requirements reduce the hedge ratio because they are costs of hedging. Trading costs directly affect the net profit from a hedging strategy. Capital requirements are "lost" from other uses while the hedge is held; although they may be returned later, they represent equity tied up in a fixed asset for a hedger that must maintain ongoing hedging activities.

Table II
CAPITAL REQUIREMENT EFFECTS ON OPTIMAL HEDGE RATIOS

Product	Price St. Dev. ($/Unit)	Annual Capital ($/Cntrt)	Annual Costs ($/Cntrt)	Capital as Hedge Ratio (%)	Costs as Hedge Ratio (%)
Cattle	0.1109	2,835	1,345	5.76	2.73
Hogs	0.0733	5,092	1,492	31.59	9.26
Soybeans	0.2241	5,232	1,886	20.83	7.51
Corn	0.171	2,991	1,835	20.46	12.55
Crude oil	1.53	7,487	1,985	31.98	8.48
Gold	27.6	8,524	1,812	11.19	2.38
S&P 500	30.01	26,431	3,920	5.87	0.87
T-bonds	600.8	8,839	1,704	2.45	0.47
Yen	626.3	8,041	1,903	1.64	0.39

Note. These hedge ratio effects are calculated assuming the risk-aversion factor equals one ($\mu = 1$).

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These changes lead to the "selective" nature of many trading strategies, compared to the hedge-and-hold strategies usually adopted by highly risk-averse hedgers.

Table II presents a cross section of results calculated with eq. (4) while assuming that $\mu = 1$. The first three columns present the standard deviation and capital/cost data needed to calculate values using eq. (4). The fourth column uses the total capital requirements (in column 2) to get the values listed.[9] Depending upon a hedger's scale of operation, the values for live cattle, the S&P 500 index, T-bonds, and Japanese yen may or may not be significant. Yet, it is highly likely that the values for live hogs, soybeans, corn, crude oil, and gold are significant in that changes in a futures hedge position can be made in the size increments recommended. The fifth column in Table II lists the hedging ratio effects of only costs incurred (commissions and interest), withouth including margin deposit requirements (which have been included thus far). While these values are much smaller in all cases, they are likely to still be significant for some products.

Table III illustrates the minimum scale of operation at which the estimated capital requirements would be significant for different degrees of risk aversion. The middle column expresses the hedge ratio results for capital requirements (from Table II) in terms of the number of futures contracts being held. In other words, a hedger with risk aversion of $\mu = 1$, who is holding at least 17 cattle futures contracts, would reduce the amount of holding in response to the need for a reduction in the hedge ratio of 5.76%. This means that the values in Table III are the "break-even" size for hedge positions which would be "significantly" affected by capital requirements. As shown in column 1, all hedgers with low risk aversion are expected to consider capital requirements when calculating the size of their optimal hedge. Yet, highly risk-averse traders (column 3) are too concerned with risk to give much thought to the relatively minor costs of hedging against risk.

CONCLUSIONS

In summary, it is expected that hedging capital requirements can be very significant in some futures markets. Selective hedging strategies, in particular, can raise both

Table III
MINIMUM HEDGE POSITION SIZE AFFECTED BY CAPITAL REQUIREMENTS

	No. of Futures Contracts at Different Risk Aversion Levels		
Product	$\mu = .01$	$\mu = 1$	$\mu = 100$
Cattle	0	17	1735
Hogs	0	3	317
Soybeans	0	5	480
Corn	0	5	489
Crude oil	0	3	313
Gold	0	9	894
S&P 500	0	17	1704
T-bonds	0	41	4084
Yen	1	61	6098

Note. These break-even position sizes are calculated simply as (1/HR), where HR is the hedge ratio effect of capital requirements estimated using eq. (4).

[9]The estimated values in columns 4 and 5 are multiplied by 100 to express them as hedge ratio percentage points.

the level of reserve capital required and the amount of transaction costs incurred. The test of significance for capital requirements presented here is applicable to any type of hedge or strategy. Although the degree of significance depends upon a person's risk attitude, it appears that capital requirements can be very important for utility-maximizing hedgers. Therefore, funding requirements should be considered as part of any hedging strategy analysis.

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