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HEDGING IN THE THEORY OF CORPORATE FINANCE: A REPLY TO OUR CRITICS

by Christopher L. Culp and
Merton H. Miller,
University of Chicago*

O n first reading the comments on our Metallgesellschaft papers[1] by Antonio Mello and John Parsons (hereafter "M&P"),[2] we had the eerie feeling that perhaps they were confusing our MGRM with another company of the same name. Surely M&P must have realized that for *our* MGRM, their standard finance models of corporate hedging were not appropriate. The standard models, focusing as they do on reducing costs of financial distress, *might* have been appropriate if our MGRM had been a stand-alone firm with independent, outside creditors. But it wasn't.

MG Refining and Marketing, Inc. (MGRM) was one subsidiary of a large German conglomerate, MG AG, in which Deutsche Bank, one of the world's biggest banks, was not only the leading creditor but, thanks to multiple cross-holdings with other stockholder firms like Allianz and Daimler Benz, also the controlling shareholder. True, the parent MG AG did undergo a major financial restructuring in January 1994, following a year of losses by MGRM and other subsidiaries; but some believe that this presumed near brush with "bankruptcy" was deliberately precipitated to provide cover for a change in management.

Rather than apply the standard finance model of hedging to a firm we saw as just the lengthened shadow of Deutsche Bank, we turned instead to the "carrying-charge hedging" model proposed long ago by Holbrook Working after years of studying the hedging policies of commercial grain merchants such as Cargill.[3] Although we gave citations in our paper to Working's analysis and its applicability to MGRM, M&P appear not to have bothered to check out those references. We begin here, therefore, by reproducing the relevant passages from the writings of Holbrook Working and by showing how Working's theory of hedging explains MGRM's strategy.

1. *See* Christopher L. Culp and Merton H. Miller, "Metallgesellschaft and the Economics of Synthetic Storage," *Journal of Applied Corporate Finance* 7(4) (Winter 1995):62-76. *See also* Christopher L. Culp and Merton H. Miller, "Hedging a Flow of Commodity Deliveries with Futures: Lessons from Metallgesellschaft," *Derivatives Quarterly* 1(1) (Fall 1994):7-15, and Christopher L. Culp and Merton H. Miller, "Auditing the Auditors," *Risk* 8(4) (April 1995).

2. Antonio S. Mello and John E. Parsons, "Maturity Structure of a Hedge Matters: Lessons from the Metallgesellschaft Debacle," *Journal of Applied Corporate Finance*, this issue. *See also* Antonio S. Mello and John E. Parsons, "Hedging a Flow of Commodity Deliveries with Futures: Problems with a Rolling Stack," *Derivatives Quarterly* 1(4) (Fall 1995 forthcoming).

3. Working's contributions may perhaps have been overlooked in the corporate finance literature because he was addressing them essentially to an audience of agricultural economists. His contributions, however, include early formulations of the cost of carry model for futures prices and the "efficient markets hypothesis." *See* Holbrook Working, "Theory of the Inverse Carrying Charge in Futures Markets," *Journal of Farm Economics* 30 (1948), Holbrook Working, "The Theory of Price of Storage," *American Economic Review* (December 1949), and Holbrook Working, "The Investigation of Economic Expectations," *American Economic Review* (1949). Working's analysis of hedging on the Chicago futures exchanges is highlighted in the papers contained in Anne E. Peck, ed., *Readings in Futures Markets Book I: Selected Writings of Holbrook Working* (Chicago: Board of Trade of the City of Chicago, 1977).

THE MOTIVATION FOR MGRM'S HEDGE

Holbrook Working categorizes standard finance models of hedging (including what is now called variance-minimizing hedging) as "pure risk-avoidance hedging."[4] Firms may hedge their value to reduce the expected costs of financial distress.[5] Or firms may hedge to reduce the variability of their net cash flows.[6] In either case, the hedging reflects some "concavity" in the firm's profit or value function that makes a value-maximizing corporation behave *as if* it were a risk-averse investor solving a traditional portfolio selection problem rather than a capital budgeting problem.

Carrying-Charge Hedging

Pure risk-avoidance hedging is only one of several types of real-world hedging Working identifies. MGRM's strategy represents what he would call "carrying-charge hedging" and what we called "synthetic storage." Working explains,

Whereas the traditional concept [of hedging] implies that hedging is merely a collateral operation that...would influence the stockholding only through making it a less risky business, the main effect of carrying-charge hedging is to transform the operation from one that seeks profit by anticipating changes in price level to one that seeks profit from anticipating changes in price relations.[7]

Carrying-charge hedging, in other words, may be undertaken by value-maximizing corporations to exploit their superior information about price *relations*, like the basis, while remaining "market neutral" with respect to spot prices. MGRM, like other carrying-charge hedgers, was essentially in the business of "trading the basis" without exposing itself to spot price risk.

Pure risk-avoidance hedging typically assumes that firms enter into forward contracting *and then* decide how to manage the risk of the position. Working's contribution was to recognize that the cash transaction and the hedge were two parts of a joint decision-making process. When information is asymmetric, he explains that

[H]edging is not necessarily done for the sake of reducing risks. The role of risk-avoidance in most commercial hedging has been greatly overemphasized in most economic discussions. Most hedging is done largely, and may be done wholly, because the information on which the merchant or processor acts leads logically to hedging....To put it briefly, we may say that hedging in commodity futures involves the purchase or sale of futures in conjunction with another commitment, usually in the expectation of a favorable change in the relation between spot and futures prices.[8] (emphasis his)

Absent superior information, value-maximizing firms may not only avoid the hedging, but may well shun the underlying activity itself.[9]

That carrying-charge hedging may be undertaken by value-maximizing firms principally if not wholly to exploit a perceived informational advantage does *not* mean that carrying-charge hedging is "speculation." Working also argues that risks are, in fact, reduced by carrying-charge hedging, even though its primary motivation need not be risk reduction:

Hedging we found not to be primarily a sort of insurance, nor usually undertaken in the expectation that spot and futures prices would rise or fall equally. It is a form of arbitrage, undertaken most commonly in expectation of a favorable change in the relation between spot and futures prices. The fact that risks are less with hedging than without is often a secondary consideration.[10] (emphasis added)

4. Holbrook Working, "New Concepts Concerning Futures Markets and Prices," *American Economic Review* (June 1962):248-53. Unless otherwise noted, all page references to Working's articles are from Peck, cited previously.

5. *See, for example,* Clifford W. Smith, Jr., Charles W. Smithson, and D. Sykes Wilford, "Financial Engineering: Why Hedge?" *Intermarket* 6(7) (1989).

6. *See, for example,* Kenneth A. Froot, David S. Scharfstein, and Jeremy C. Stein, "Risk Management: Coordinating Corporate Investment and Financing Policies," *Journal of Finance* 48(5) (December 1993):1629-1658.

7. Working (1962), cited previously:249.

8. Holbrook Working, "Futures Trading and Hedging," *American Economic Review* (June 1953), quoted from *Selected Readings of Holbrook Working,* cited previously:148-149

9. We need hardly remind readers that most value-maximizing firms do not, in fact, hedge. Chase Manhattan Bank and The Wharton School recently surveyed 1,999 non-financial U.S. firms randomly selected from COMPUSTAT tapes. Of the 530 firms responding, only 35% answered "yes" when asked if their firms buy or sell futures, forwards, options, or swaps. *See* "The Wharton/Chase Derivatives Survey," in Charles W. Smithson, *Managing Financial Risk: 1995 Yearbook* (Princeton, NJ: The Chase Manhattan Bank, 1995):159.

10. Working (1953), cited previously:163.

Because a value-maximizing firm engaged in synthetic storage exchanges its natural exposure to the absolute price level for a net exposure to *relative prices*, synthetic storage virtually always reduces the variance of the value of the firm. Had MGRM undertaken its long-term marketing program *unhedged*, the volatility of its net income would have been proportional to the volatility of *spot* prices. Hedged, the volatility of MGRM's net income was proportional instead to the volatility of the bases reflected in the futures contracts MGRM held (i.e., contracts with one, two, and three months to maturity). As we have shown, the volatility of spot prices is huge relative to the volatility of the bases in those contracts.[11] Hence, MGRM chose to exploit its informational advantage by hedging rather than simply taking a position in the underlying commodity.

That MGRM saw itself as a carrying-charge hedger in the Working tradition is clear in this excerpt from MG AG's 1991/92 *Annual Report*, on which the supervisory board members of MG AG placed their signatures:

While the futures markets provide hedging vehicles that reflect the realities of the crude oil markets, petroleum products remain a different story. Regional supply-demand differences can introduce major basis risk....A solid presence in the physical markets and the resulting awareness of local refinery economics enable the MG Energy Group to turn that difficulty into an advantage.[12]

Like Working, MGRM even referred to its hedging objective as a type of basis arbitrage:

At any given point in time, certain parts of the commodity market may be over-valued or undervalued relative to that commodity's own forward price curve, to other commodities, or to other markets....That, in turn, provides attractive opportunities from an arbitrage standpoint.[13]

What About Expected Bankruptcy Costs? MGRM's strategy of carrying-charge hedging rather than standard finance risk-avoidance hedging makes perfect sense under the assumption that *basis risk* exposed MGRM to no real threat of bankruptcy, whereas naked spot price exposure might well have.[14] M&P seem to believe that MGRM should have been much more concerned with bankruptcy, even in its core business of basis trading. Addressing bankruptcy concerns by reducing the size of the program as M&P and others have recommended can be a mixed blessing, however. As explained in Edwards and Ma, "Hedgers...may be willing to assume more risk in order to assume greater profits. Eliminating all...risk often means eliminating all profit, a condition that most businesses cannot tolerate for long."[15]

M&P's obsession with bankruptcy in this case rests heavily on their interpretation of the events of December 1993 in which the cash flow strains of MGRM's hedge supposedly did in the program. But the turn of events *ex post* does not establish whether MGRM was correct in seeing itself as an effectively risk-neutral corporation *ex ante*—particularly so in this case, because of the still unresolved doubts over whether that liquidity crisis was real or contrived.

As a stand-alone firm, MGRM and its outside creditors might well have been concerned with the costs of bankruptcy or depleted cash for investment expenditures, especially after the large margin calls of late 1993. But MGRM was *not* a stand-alone firm. Deutsche Bank was not only the principal *inside* creditor and principal shareholder of MG AG, but thanks to its cross-holdings, it was also effectively the *controlling* shareholder. With Deutsche Bank thus standing *in loco parentis*, as it were, what sense does it make to assume that MGRM could be brought to ruin by the cash requirements of a *hedged* program? And does anyone seriously think that the NYMEX would have allowed MGRM to take positions as large as 55,000 contracts without an assurance that Deutsche Bank stood behind the firm? Or that swap dealers would have negotiated nearly 100 million additional barrels of contracts without requiring enormous collateral? As one swap dealer commented, "[T]here was a feeling in the market that [MGRM] was the

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11. *See* Culp and Miller (Winter 1995), cited previously:67. No more than 1 to 5% of the historical variation in front-month futures prices can be traced to variations over time in the basis.

12. Metallgesellschaft AG *Annual Report* (1991/92):40.

13. "MGRM: Hedging Strategies Revisited," Exhibit E in *W. Arthur Benson v. Metallgesellschaft Corp. et. al.*, Civ. Act. No. JFM-94-484. U.S.C.D. Md. (October 3, 1994):E13.

14. Looking at the problem in this way is equivalent to seeing MGRM as "locally" risk-neutral. Positive bankruptcy costs, for example, might have led MGRM to hedge its spot price risk, but once hedged it behaved as an essentially risk-neutral basis trader. *See* Culp and Miller (Winter 1995):footnote 6.

15. Franklin R. Edwards and Cindy W. Ma, *Futures and Options* (New York: McGraw-Hill, Inc., 1992):141.

Bundesbank: the Bundesbank would bail out Deutsche Bank, which stood behind MG. The ultimate risk was the country."[16,17]

Surely no controversy would have arisen about Deutsche Bank's ability to finance MGRM's program without flinching had the program been for 15 million bbls. rather than 150 million bbls. The issue thus comes down to how big a commitment is "too big" for a Deutsche Bank; and if there was such a maximum that Deutsche Bank was prepared to back, why the supervisory board of MG AG had not communicated it as policy earlier.

As a further irony, Thornton Oil Corp. sued MG when the new management's boasts of having narrowly averted bankruptcy first surfaced.[18] Even though its delivery contracts were "out-of-the-money," Thornton wanted its contracts to continue and demanded assurances from MG to that effect. The issue had not arisen earlier because the customers had been contractually assured MGRM would remain hedged, with Deutsche Bank believed to be standing behind the agreements through thick or thin.[19]

Why a One-for-One Hedge?

Because synthetic storage or carrying-charge hedging differs from pure risk avoidance hedging, so naturally does the "optimal" hedging strategy. For a carrying-charge hedger, that optimal strategy is "one-for-one" (subject, of course, to any tailing).[20] M&P's frequent stigmatizing as "speculation" any futures held in excess of the much smaller "optimal" hedge implied by their analysis is thus just a verbal trick.[21]

A firm entering into a carrying-charge hedge does so because of superior information it has on *relative* prices (i.e., the basis), not on *absolute* spot

prices. M&P believe this amounts to saying that futures are "mispriced." Not so. Futures prices reflect the equilibrium expected basis conditional on information possessed by the *marginal* market participant. That MGRM's conditioning information might be different from that of the marginal participant does not imply a mispricing, though it does offer a sufficient rationale for carrying-charge hedging.

MGRM's simple one-for-one hedging strategy had a further important *organizational* advantage for the shareholders of its German parent MG AG: it could easily be monitored at the end of every trading day.[22] By comparing the amount of futures and swaps to the underlying customer contracts, MG AG's management board could safely leave the details of the hedging program to MGRM without fear that someone might be covertly betting the ranch on price moves in Leeson/Barings fashion.

WHAT WAS THE INITIAL NET PRESENT VALUE OF THE PROGRAM?

Our quarrel with M&P is more than just the semantic issue of what constitutes "hedging" and what constitutes "speculation." By using inappropriate assumptions in their models, M&P have also been led to mis-estimate—by a *huge* amount—the true value of MGRM's combined hedging/delivery program.

M&P's Table 2 summarizes what they call *"ex ante"* estimates of the value of MGRM's customer contracts, both hedged and unhedged. Using an estimate of $3/bbl. for the initial gross profit margin, they put the gross present value of the contracts at $63.6 million for 150 million bbls. of customer contract sales. Their estimates of net value are $59.2 million for the unhedged contracts and $35.1 million for the hedged program.

16. Quoted in David Shirreff "In the Line of Fire," *Euromoney* (March 1994):42-43.

17. Remember also that Deutsche Bank had earlier announced to all—in MG AG's 1992-93 company newsletter, no less—that it had increased MG's 5-year credit line to DM1.5 billion, a credit line intended, among other things, to serve as "a permanently available reserve of liquidity." *See* "DM1.5 Billion Credit Line Granted to MG," *MG UPDATE: Company News from Around the World* (2/92). MG officials now claim that the credit line was intended only as a back-up provision for the Commercial Paper Program. But as even MG AG's Special Auditors note, no such restriction was mentioned in the documentation for the credit facility. *See* MG AG's Special Audit:3.3.3.5.

18. *See Thornton Oil Corp. v. MG Refining and Marketing, Inc.*, Civ. Act. No. 94CI101653, Circuit Court of Jefferson County, KY (1994).

19. Three related cases involve counter-claims by several customers against MGRM that it has not provided adequate assurances of its ability to honor its long-term customer contracts—assurances that were apparently sufficient *ex ante. See* Counterclaim, *MG Refining and Marketing, Inc. v. Knight Enterprises, Inc. v. MG*

Refining and Marketing, Inc., et. al., Civ. Act. No. 94-2512, U.S.D.C.S.D.N.Y. (April 4, 1994); Counterclaim, *MG Refining and Marketing, Inc. v. R.L. Jordan Oil Company, Inc.*, Civ. Act. No. 94-7804, U.S.D.C.S.D.N.Y. (October 27, 1994); Counterclaim, *MG Refining and Marketing, Inc. v. A.T. Williams Oil Company v. MG Refining and Marketing, Inc., et. al.*, Civ. Act. No. 94-7862, U.S.D.C.S.D.N.Y. (October 31, 1994).

20. Technically, the objective function is to maximize expected net present value subject to remaining market-neutral.

21. In this version of their paper, M&P now admit that MGRM *was* hedged against spot price risk, but they dismiss the hedging strategy as "rolling the dice" on the basis. That is like saying a market-neutral swap dealer is rolling the dice on credit risk.

22. The Group of Thirty has endorsed the notion of transparent exposure monitoring, though not necessarily daily. *See* Global Derivatives Study Group, *Derivatives: Practices and Principles* (Washington, DC: The Group of Thirty, July 1993).

M&P's simulated estimates of gross and net present values can only be described as weird. They assume, among other things, a $2/bbl. "cost of delivery." Actually, the prices in MGRM's contracts were FOB, making M&P's deduction of a $2/bbl. delivery cost totally absurd. But, we suppose, once M&P had made up their minds that the program was worthless, what was another two or three hundred million dollars?

M&P's adjustment from the gross present value of the program unhedged to the net present value of the program hedged is equally strange. The costs of financing the hedge are driven almost entirely by M&P's assumption that external financing costs rise exponentially as prices fall. But the issue of whether *any* external financing really was required is what the shouting is all about. And it is still very much a matter of dispute, currently being fought out in courtrooms around the world. Had Deutsche Bank stepped up to the plate in December the way MGRM's original management expected it to and the way it actually did two months later in the MG AG restructuring, no "external" financing would have been needed. In sum, rather than present a well-reasoned estimate of the value of the program, M&P simply *assume* the answer they wanted.

The correct approach for computing the initial value of MGRM's program was presented and illustrated in our earlier article, but we gave no precise calculations.[23] The numbers appear, however, in our recent article in *Risk* magazine.[24] We assume there that MGRM sold forward 150 million bbls. of oil in its flow contracts at a $3/bbl. gross margin. We take the *expected* basis as zero, which is actually a conservative assumption for early 1993 given the backwardation in the market at the time (as well as historically). Our estimate of the initial discounted expected net present value at the inception of MGRM's program was at least $450 million—an amount $414.9 million higher than M&P's!

WHAT WAS THE 1993 NET ECONOMIC LOSS?

In addition to their estimates of initial gross and net present values, M&P attempt to estimate MGRM's gross and net *losses* in 1993. They put the gross losses on MGRM's hedge in their Table 1 at about $1.174 billion. To get to their net loss estimate, they subtract the *change* in the value of MGRM's customer contracts in 1993 from their gross loss estimate. Using "present value factors" based on a paper by Gibson and Schwartz, [25] which M&P present in their Table 3, they estimate in Table 4 the gain on the customer contracts as about $479 million in 1993. (Curiously, M&P seem to sense no "cognitive dissonance" between their estimate that the contracts *gained* in value by nearly half a billion dollars in 1993, but were worth only $59 million to start with. Can it be that one of the co-authors did Table 2 and the other Table 4?) Subtracting that $479 million from the $1.174 billion gross loss gives them a net loss of $695 million for MGRM that year.

Gibson and Schwartz, on whom M&P rely so heavily, freely concede that their present value factors for oil delivered in the future turned out to be extremely low, surprisingly so even to them. Their model implies that prices of oil derivatives are determined at the margin by risk-averse investors who demand a premium over and above the riskless rate for bearing convenience yield (i.e., basis) risk.[26] Their reasoning is reminiscent of Keynes' classic discussion of the returns to speculators and hedgers.[27] Keynes believed that commodity futures risk premiums were positive and large, but his view commands little support.[28] Although Gibson and Schwartz assume the presence of a risk premium in oil, they recognize that it can be estimated only subject to substantial measurement error.[29] For that reason, they warn that their present value factors "must be interpreted with caution"—advice, alas, M&P ignored.[30]

Our valuation model, in contrast with Gibson and Schwartz (hence, also M&P), but in accordance

23. *See* Culp and Miller (Winter 1995):equation (1). Strictly speaking, St in equation (1) is part of the summand, and the entire summand should be multiplied by (1+Et(wt,j)), the interest-adjusted basis. We omitted that term for simplicity, because our concern there was with sufficient conditions for profitability under worst-case assumptions (i.e., contango). Including this term only increases the number of situations for which the sufficiency test is satisfied.

24. Culp and Miller (April 1995), cited previously.

25. Rajna Gibson and Eduardo S. Schwartz, "Stochastic Convenience Yield and the Pricing of Oil Contingent Claims," *Journal of Finance* 45(3) (July 1990).

26. Gibson and Schwartz rely on a general methodology developed by Michael J. Brennan and Eduardo S. Schwartz, "A Continuous Time Approach to the Pricing of Bonds," *Journal of Banking and Finance* 3 (1979).

27. John Maynard Keynes, *The Theory of Money: Volume II, The Applied Theory of Money* (London: Macmillan, 1950):Book VI, Chapter 29, (iii)-(v).

28. *See, for example,* Lester Telser, "Futures Trading and the Storage of Cotton and Wheat," *Journal of Political Economy* 66 (June 1958), and Katherine Dusak, "Futures Trading and Investor Returns: An Investigation of Commodity Market Risk Premiums," *Journal of Political Economy* 87(6) (December 1973).

29. *See also* Eugene F. Fama and Kenneth R. French, "Commodity Futures Prices: Some Evidence on Forecast Power, Premiums, and the Theory of Storage," *Journal of Business* 60(1) (January 1987).

30. Gibson and Schwartz, cited previously:972-73.

with most discussions of commodity pricing these days, assumes that equilibrium prices for oil derivatives are determined by buyers and sellers who are effectively risk-neutral. We have presented our own method of calculating MGRM's 1993 net economic loss elsewhere and need not repeat the calculations in detail here.[31] Suffice it to say that when we put all the separate pieces together—and remembering that, thanks to the hedge, the pure spot price change (net of rollover costs) raises the capital value of the flow contracts by exactly as much as the cash loss on the futures—we calculate the net 1993 loss for MGRM as the *initial* capital asset value of the program less unexpected 1993 rollover costs and less the change in conditional expected rollover costs during the year, or

$450 million - $250 million - $370 million = -$170 million.

Thus, even after ruling out any future rollover gains from backwardation, we estimate MGRM's 1993 net loss at roughly $170 million, or just a fourth of M&P's $695 million net loss estimate.

Losing even $170 million is hardly pleasant, needless to say, but that figure by itself does not indicate that the program should have been ended in 1993. The $170 million is simply the cumulative loss through the year 1993—that is, after one year of operation. Those losses would be correspondingly reduced were we to recompute the cumulative losses on a program continued through the end of 1994, by which time the flattening of the term structure would have dramatically reduced realized and conditional expected future rollover costs. In fact, by April 1995, had the program been continued it would have shown a substantial *net profit*.

What Were the Alternatives in December 1993?

M&P argue that "[t]he lingo of the derivatives industry and its relative novelty has allowed a number of speculative activities to be passed off as 'risk management.' MGRM's losses in late 1993 made this pretense no longer possible, and Metallgesellschaft's shareholders and creditors took the necessary remedial actions to limit the sorry consequences." But to invoke past losses as a justification for ending the program is to be taken in by the sunk cost fallacy. Regardless of how big past losses may have been, the test for *continuing* a program is the same as for *initiating* it: Is the conditional expected net present value positive? After the spot price decline of $5.575/bbl in 1993, which widened the gross margin in the customer contracts to more than $8/bbl., the net present value at that point was surely positive.

Even if management wanted to end its participation in the program, the 1993 increase in the capital value of the customer contracts could, in principle at least, have been realized by selling the program to another firm. MGRM could not, of course, recover past losses simply by selling the program at market prices (any more than an investor can recover *past* losses by selling a stock), but at least selling the program would have staunched the cash drains with which MG AG's supervisory board had become so obsessed.[32] Whether to continue the program or sell it can be shown to depend almost entirely on whether prospective buyers' expectation of future rollover costs were less than MGRM's.[33]

MGRM also had a third alternative. Rather than continuing the program intact or selling the program as a whole, the company could have attempted to scale down the program by simultaneously reducing the hedge and unwinding its customer contracts at the best possible prices. And after a $5.575/bbl decline in spot prices in 1993, the "best possible price" for unwinds should have been substantial.[34] What MG AG's supervisory board actually did in December 1993 was none of the above. They liquidated much of MGRM's futures hedge and canceled valuable customer contracts *with no compensation required*.[35] As we have explained elsewhere, this decision cost shareholders dearly.[36]

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31. *See* Culp and Miller (April 1995), cited previously.

32. By purchasing puts, MGRM could have both limited its cash outlays and bought itself time to decide on the appropriate means for ending the program.

33. *See* Culp and Miller (April 1995), cited previously.

34. That customers might have been willing to pay less than another firm buying the whole program cannot be ruled out. Customers presumably would use a higher discount rate than MGRM or an outside bank in valuing the contracts. Once MGRM's troubles became public, moreover, customers would have possessed an unusual amount of leverage over MGRM in negotiating the prices for bilateral unwinds or transferring the contracts to another firm.

35. That MG's canceled contracts had *some* value is confirmed on the public record. On December 22, 1993, one of MGRM's biggest firm-flexible customers reportedly paid MGRM $2 million to terminate its firm-flexible contracts. New management accepted the offer. Two months later when most of the remaining firm-flexible contracts were canceled with no compensation required from customers, MG refunded the $2 million it had been paid earlier. *See* Cindy W. Ma, "Rebuttal to the Special Audit Report," manuscript sent to MG AG shareholders (March 7, 1995), 4.4.3.

36. Culp and Miller (April 1995), cited previously.

POST-SCRIPT ON EDWARDS & CANTER

We apologize to Messrs. Edwards and Canter (E&C) for neglecting their paper and concentrating exclusively on M&P.[37] E&C bring little to the party that has not already been covered by us—several times, actually—except their computation of "variance-minimizing" hedge ratios. We ignored variance-minimizing hedge ratios because, as explained earlier, they are irrelevant for MGRM. Anyway, E&C did not even calculate them correctly.[38] E&C do allow explicitly for "tailing," but we had ignored this adjustment only for simplicity of exposition.[39]

E&C also remind us that MGRM's program would have suffered even greater losses than the $170 million we estimated for 1993 had the market gone further into contango. We certainly have no quarrel with that, but E&C might have mentioned that the market did *not* slip further into contango in 1994. Quite the contrary. Nor do we disagree with their computations of rollover costs for beans and copper, although we are not sure what point E&C were trying to make with them. That virtually all markets for storable, non-petroleum commodities are normally in contango is well-known, after all. Perhaps they were simply cautioning firms proposing to offer MGRM-style long-term, fixed-price contracts in beans or copper to be sure and set their initial gross margins higher than might be appropriate for a chronically-backwardated market like crude oil.

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37. Franklin R. Edwards and Michael S. Canter, "The Collapse of Metallgesellschaft: Unhedgeable Risks, Poor Hedging Strategy, or Just Bad Luck?" *Journal of Applied Corporate Finance*, this issue. *See also* Franklin R. Edwards and Michael S. Canter, "The Collapse of Metallgesellschaft: Poor Hedging Strategy or Just Bad Luck?" *Journal of Futures Markets* 15(3) (May 1995).

38. For an equally irrelevant but econometrically superior estimation method, *see* Stephen Craig Pirrong, "Metallgesellschaft: A Prudent Hedger Ruined, or A Wildcatter on NYMEX?" Manuscript (February 1995).

39. *See* Culp and Miller (Winter 1995):footnote 13.

■ CHRISTOPHER CULP

is a financial risk management consultant in Chicago and a doctoral candidate in finance at The University of Chicago's Graduate School of Business.

■ MERTON MILLER

is the Robert R. McCormick Distinguished Service Professor Emeritus at the University of Chicago's Graduate School of Business.