MGRM's Hedging Revisited

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MGRM's Hedging Background Information

- MG Refining & Marketing - US Subsidiary of German firm Metallgesellschaft
- One of the largest derivatives trading losses in history
- Sparked a large academic debate

MGRM's Hedging Practices

- In 1991 MGRM began offering long-term fixed price deliveries on refined products (Gasoline & Heating oil)
- By December, 1991 hold sold forward the equivalent of 160 million barrels
- Hedged with a 1-for-1 stack and roll futures hedge (mostly) in the nearby NYMEX contracts
- Relied on a long-term trend of backwardation to systematically earn roll-over profits
- By December, 1993 the market moved to contango
- MGRM began experiencing large paper losses (hedging cash flows were mismatched with contract cash flows)
- Management eventually lifted the hedge, leading to massive losses (approx. $1.4b)

The Academic Debate

- MGRM's hedging was roundly criticized by academics
- Famously (infamously?) Culp & Miller defended MGRM's hedging practice as essentially sound
- The main criticisms:
    - The 1-for-1 hedge ratio was hugely speculative (relative to a minimum-variance benchmark)
    - The stack-and-roll was dangerous - MGRM should have used a strip hedge by matching contract and hedging cash flows
    - Huge operational risk (geeks vs suits)

The Academic Debate Continued

Con:

- Mello & Parsons (1995)
- Edwards & Canter (1995)
- Pirrong's BAG (VECM-MGARCH) hedging ratio analysis (1997)

Pro:

- Culp & Miller (1994, 1995a, 1995b)
- Bollen & Whaley (1998)

Empirical Results

The Importance of the Loss Function

- It seems the academic debate has really been a debate about the loss function used to evaluate the performance of MGRM's hedging practices.
  - Most of the academic criticism evaluated MGRM from the perspective of a mimimum-variance (or volatility reduction) loss function that is standard in that literature
  - Culp & Miller point out that MGRM were more in line with Holbrook Working's carrying-charge (or arbitrage) hedging
- This suggests a loss function based more on the profitability of trading than variance reduction.
  - Cash flows may have been reduced from the no-hedge position, but this is a secondary motivation at most

Alternative Loss Functions

- To this end we evaluate the following loss functions:

$$r_{m,t+1} = \ln\left[\Delta S_{t+1} - \gamma_m^* \Delta F_{t+1}\right] - \ln\left[\Delta S_{t+1} - \gamma_0 \Delta F_{t+1}\right]$$

and

$$v_{m,t+1} = \left[\Delta S_{t+1} - \gamma_m^* \Delta F_{t+1}\right]^2 - \left[\Delta S_{t+1} - \gamma_0 \Delta F_{t+1}\right]^2$$

where

- γ_m is the fixed hedge ratio from 0.0 to 1.0 by 0.05
- $\gamma_0 = 0.0$ is the no-hedging benchmark

Loss Functions Continued

We base our findings on the average loss values

$$\bar{r}_m = (n)^{-1} \sum_{t=R}^{T} r_{m,t+1}$$

and

$$\bar{v}_m = (n)^{-1} \sum_{t=R}^{T} v_{m,t+1}$$

for $m = 1, \ldots, 21$ where $\gamma_m = 0.0, 0.05, \ldots, 0.95, 1.0$.

Historical Results

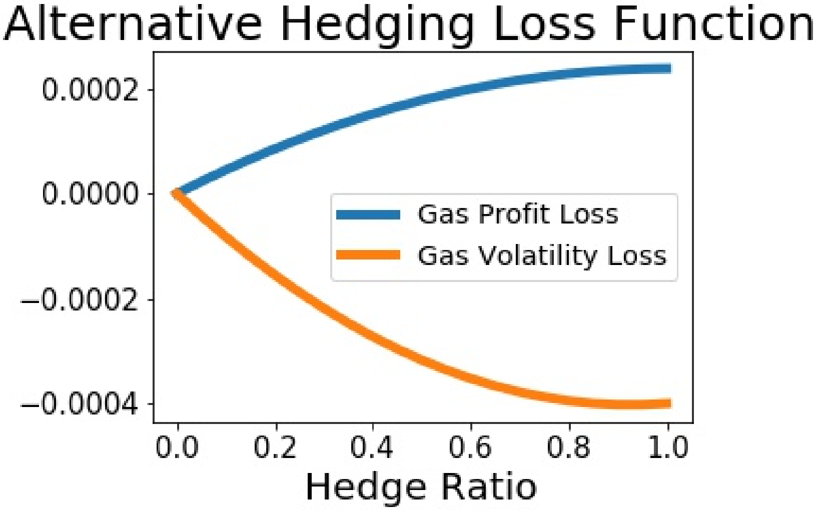

Figure 1: Loss Functions for Gasoline

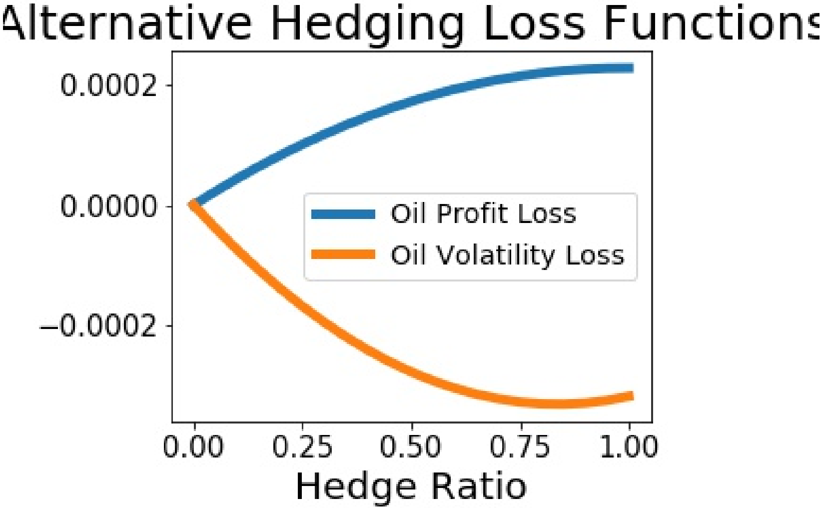

Figure 2: Loss Functions for Heating Oil

The Bootstrap Hedging Simulator

The Bootstrap Snooper

- These simple graphs tell quite a story, but one has to account for data snooping
- We employ the bootstrap to estimate the sampling distribution of the two loss functions
- Specifically we employ the Stationary Bootstrap of Politis & Romano (JASA 1994)

Bootstrap Results

Gas Profit Measure

Table 1: Summary Statistics: Gas Profit/Loss Function

Hedge Ratio	Mean	Std	Max	Min
0.00	0.0000	0.0000	0.0000	0.0000
0.05	0.8320	0.0003	3.2452	-1.3918
0.10	1.6375	0.0007	7.2309	-3.3342
0.15	2.4382	0.0011	11.0771	-5.1152
0.20	3.1773	0.0014	15.0206	-7.6481
0.25	3.8091	0.0017	19.3101	-9.3906
0.30	4.5294	0.0021	23.1028	-11.5474
0.35	4.9630	0.0024	33.6720	-13.8958
0.40	6.1128	0.0028	33.9684	-12.7379
0.45	6.3096	0.0031	35.0237	-13.4155

Gas Profit Measure Continued

Table 2: Summary Statistics: Gas Profit/Loss Function

	Hedge Ratio	Mean	Std	Max	Min
11	0.50	6.6270	0.0034	40.7192	-15.6242
12	0.55	7.3348	0.0037	44.0379	-19.6954
13	0.60	8.1243	0.0041	54.9010	-21.5118
14	0.65	7.7567	0.0044	51.0784	-26.1954
15	0.70	8.2257	0.0050	59.5195	-21.9163
16	0.75	7.8171	0.0054	62.2016	-27.8206
17	0.80	8.9409	0.0055	76.1539	-35.0146
18	0.85	8.9291	0.0057	74.0379	-30.4498
19	0.90	8.7397	0.0061	69.5862	-31.1291
20	0.95	9.8116	0.0066	77.4831	-34.3072
21	1.00	8.4479	0.0066	90.5644	-31.9057

Oil Profit Measure

Table 3: Summary Statistics: Oil Profit/Loss Function

Hedge Ratio	Mean	Std	Max	Min
0.00	0.0000	0.0000	0.0000	0.0000
0.05	0.8062	0.0003	3.1096	-1.9732
0.10	1.6338	0.0006	6.3779	-3.3377
0.15	2.3559	0.0010	10.8457	-6.7237
0.20	2.9742	0.0013	13.5426	-6.1443
0.25	3.6567	0.0016	17.8616	-10.0297
0.30	4.2965	0.0019	20.7370	-10.5307
0.35	4.9443	0.0022	27.3800	-10.9543
0.40	5.3280	0.0024	24.8782	-13.3414
0.45	5.9935	0.0028	35.5839	-15.0091

Oil Profit Measure Continued

Table 4: Summary Statistics: Oil Profit/Loss Function

	Hedge Ratio	Mean	Std	Max	Min
11	0.50	6.4897	0.0032	36.9037	-16.6382
12	0.55	6.7628	0.0035	45.7113	-20.3625
13	0.60	7.1869	0.0038	45.9573	-19.8934
14	0.65	7.4941	0.0040	42.5505	-21.0478
15	0.70	7.7543	0.0044	51.7815	-27.5352
16	0.75	8.1628	0.0047	52.8012	-26.9758
17	0.80	8.2504	0.0051	60.6985	-31.1906
18	0.85	7.8102	0.0054	63.1625	-27.2003
19	0.90	8.4370	0.0058	66.9608	-30.0857
20	0.95	8.3525	0.0059	70.3066	-28.0777
21	1.00	8.7819	0.0063	76.3428	-38.3311

Gas Profit-Loss Function Histogram

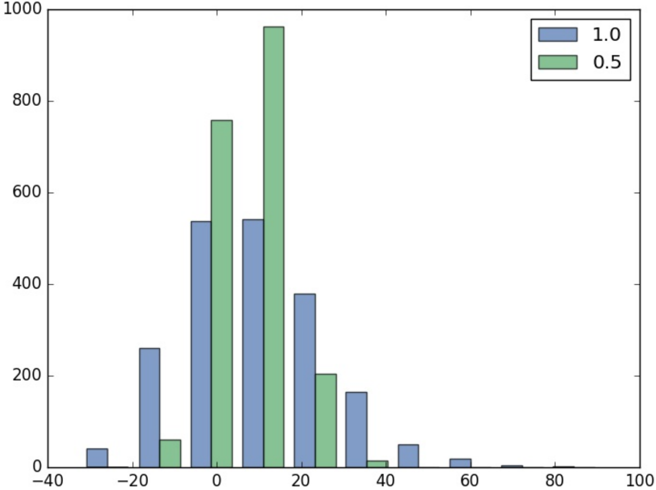

Figure 3: Bootstrapped Profit/Loss for Gasoline

Gas Volatility-Loss Function Histogram

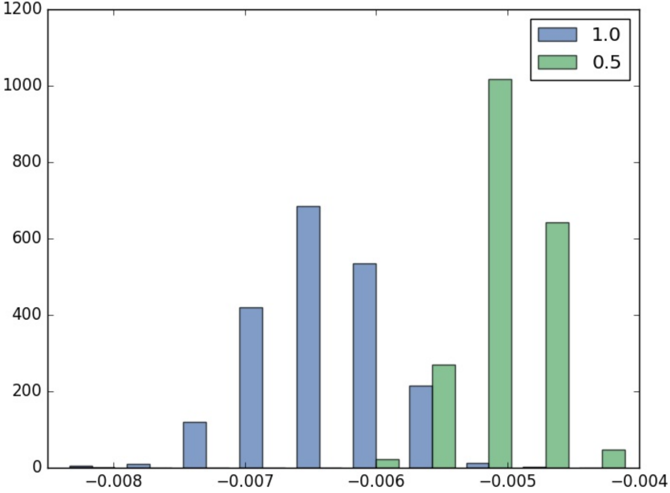

Figure 4: Bootstrapped Volatility Loss for Gasoline

Oil Profit-Loss Function Histogram

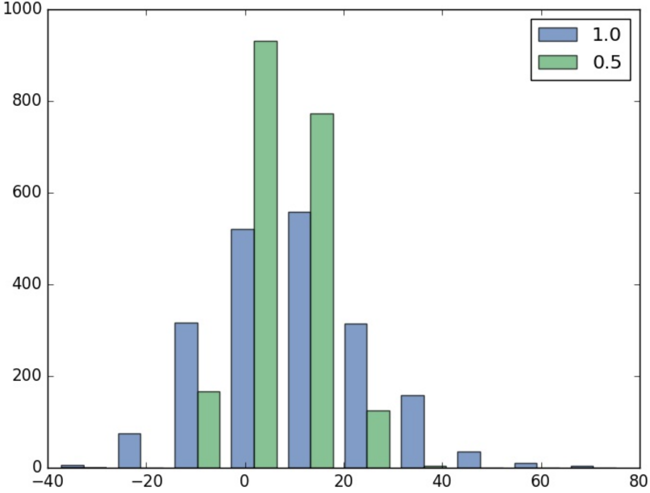

Figure 5: Bootstrapped Profit/Loss for Oil

Oil Volatility-Loss Function Histogram

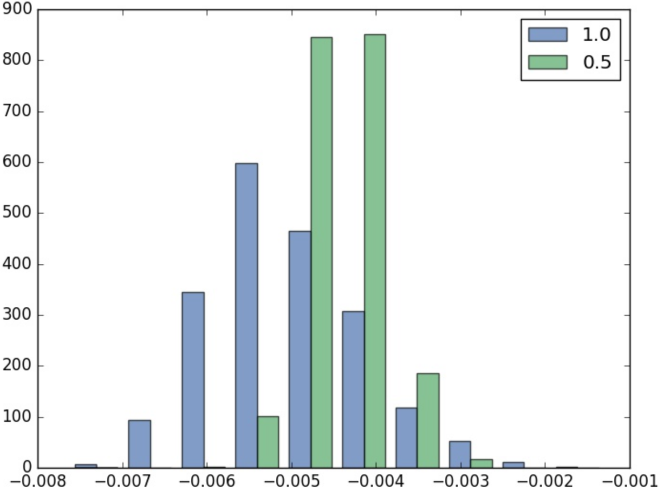

Figure 6: Bootstrapped Volatility Loss for Oil

Summary

- We have highlighted the importance of the loss function in evaluating hedging peformance
- This applies especially to the academic debate over MGRM's hedging
- According to the returns-based loss function, MGRM's fixed-ratio 1-for-1 hedge ratio was superior
- Perhaps much of the historical debate amounted to economists speaking past eachother

Next Steps

- Out bootstrap results are strongly suggestive, but we need to formalize our tests
- Employ the following: White's RC, Hansen's SPA, Romano & Wolf's MCP
- One of Pirrong's strong criticisms was that MGRM did not properly dynamically hedge
  - We will then include his BAG estimator as the benchmark
  - Also include more recent advancements in dynamic heding (such as Alizadeh et al's MRS-BEKK)
- Other measures of loss:
  - Total terminal cash flows
  - Keep track of liquidity problems (e.g. percentage of simulations with capital losses below some threshold)
- Consider other strategies to augment MGRM's historical hedging practices
  - Synthetic capital policies
  - Option-based delta hedging