MGRM's Hedging Revisited

Tyler J. Brough & Andrew Brim

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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

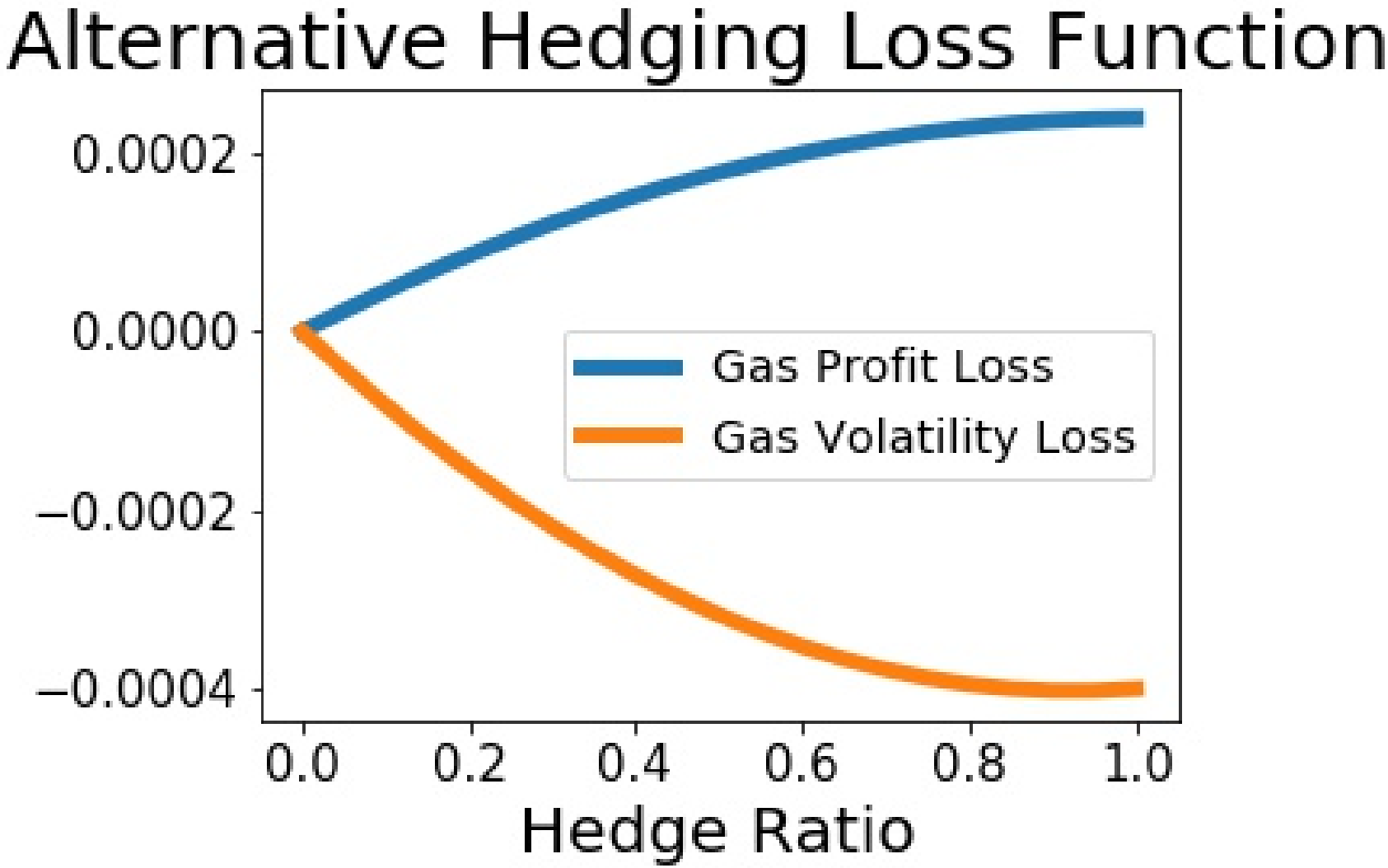

Figure 1: Loss Functions for Gasoline

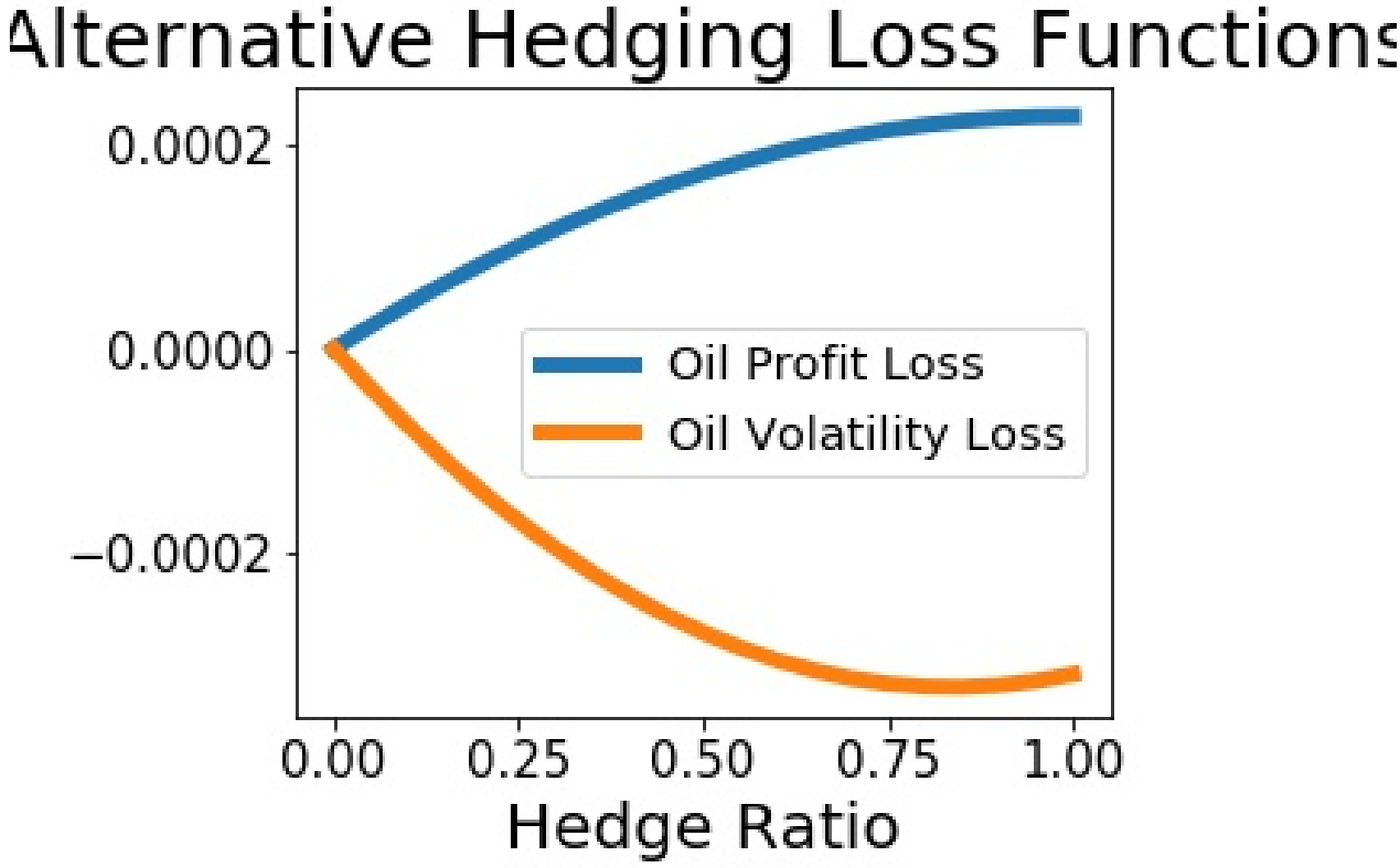

Figure 2: Loss Functions for Heating Oil

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	Max	Min	Std
0.00	0e+00	0e+00	0e+00	0e+00
0.05	0e+00	1e-04	0e+00	0e+00
0.10	0e+00	2e-04	-1e-04	0e+00
0.15	1e-04	3e-04	-1e-04	1e-04
0.20	1e-04	4e-04	-2e-04	1e-04
0.25	1e-04	5e-04	-3e-04	1e-04
0.30	1e-04	6e-04	-3e-04	1e-04
0.35	1e-04	8e-04	-4e-04	2e-04
0.40	2e-04	8e-04	-4e-04	2e-04
0.45	2e-04	8e-04	-4e-04	2e-04

Gas Profit Measure Continued

Table 2: Summary Statistics: Gas Profit/Loss Function

	Hedge Ratio	Mean	Max	Min	Std
11	0.50	2e-04	0.0009	-0.0005	2e-04
12	0.55	2e-04	0.0010	-0.0006	2e-04
13	0.60	2e-04	0.0012	-0.0007	3e-04
14	0.65	2e-04	0.0011	-0.0008	3e-04
15	0.70	2e-04	0.0013	-0.0007	3e-04
16	0.75	2e-04	0.0013	-0.0009	3e-04
17	0.80	2e-04	0.0016	-0.0012	3e-04
18	0.85	2e-04	0.0015	-0.0010	4e-04
19	0.90	2e-04	0.0014	-0.0010	4e-04
20	0.95	3e-04	0.0016	-0.0012	4e-04
21	1.00	2e-04	0.0018	-0.0011	4e-04

Gas Volatility Measure

Table 3: Summary Statistics: Gas Volatility Loss Function

Hedge Ratio	Mean	Max	Min	Std
0.00	0e+00	0e+00	0e+00	0
0.05	0e+00	0e+00	-1e-04	0
0.10	-1e-04	-1e-04	-1e-04	0
0.15	-1e-04	-1e-04	-2e-04	0
0.20	-2e-04	-1e-04	-2e-04	0
0.25	-2e-04	-2e-04	-2e-04	0
0.30	-2e-04	-2e-04	-3e-04	0
0.35	-2e-04	-2e-04	-3e-04	0
0.40	-3e-04	-2e-04	-3e-04	0
0.45	-3e-04	-2e-04	-4e-04	0

Gas Volatility Measure Continued

Table 4: Summary Statistics: Gas Volatility Loss Function

	Hedge Ratio	Mean	Max	Min	Std
11	0.50	-3e-04	-3e-04	-4e-04	0
12	0.55	-3e-04	-3e-04	-4e-04	0
13	0.60	-4e-04	-3e-04	-4e-04	0
14	0.65	-4e-04	-3e-04	-4e-04	0
15	0.70	-4e-04	-3e-04	-5e-04	0
16	0.75	-4e-04	-3e-04	-5e-04	0
17	0.80	-4e-04	-3e-04	-5e-04	0
18	0.85	-4e-04	-3e-04	-5e-04	0
19	0.90	-4e-04	-3e-04	-5e-04	0
20	0.95	-4e-04	-3e-04	-5e-04	0
21	1.00	-4e-04	-3e-04	-5e-04	0

Oil Profit Measure

Table 5: Summary Statistics: Oil Profit/Loss Function

Hedge Ratio	Mean	Max	Min	Std
0.00	0e+00	0e+00	0e+00	0e+00
0.05	0e+00	1e-04	-1e-04	0e+00
0.10	0e+00	2e-04	-1e-04	0e+00
0.15	1e-04	3e-04	-2e-04	1e-04
0.20	1e-04	3e-04	-2e-04	1e-04
0.25	1e-04	5e-04	-3e-04	1e-04
0.30	1e-04	5e-04	-3e-04	1e-04
0.35	1e-04	7e-04	-3e-04	1e-04
0.40	1e-04	6e-04	-4e-04	2e-04
0.45	2e-04	8e-04	-4e-04	2e-04

Oil Profit Measure Continued

Table 6: Summary Statistics: Oil Profit/Loss Function

	Hedge Ratio	Mean	Max	Min	Std
11	0.50	2e-04	0.0009	-0.0005	2e-04
12	0.55	2e-04	0.0010	-0.0006	2e-04
13	0.60	2e-04	0.0010	-0.0006	2e-04
14	0.65	2e-04	0.0010	-0.0006	3e-04
15	0.70	2e-04	0.0011	-0.0009	3e-04
16	0.75	2e-04	0.0012	-0.0009	3e-04
17	0.80	2e-04	0.0013	-0.0010	3e-04
18	0.85	2e-04	0.0013	-0.0009	3e-04
19	0.90	2e-04	0.0014	-0.0010	4e-04
20	0.95	2e-04	0.0015	-0.0009	4e-04
21	1.00	2e-04	0.0016	-0.0013	4e-04

Oil Volatility Measure

Table 7: Summary Statistics: Oil Volatility Loss Function

Hedge Ratio	Mean	Max	Min	Std
0.00	0e+00	0e+00	0e+00	0
0.05	0e+00	0e+00	-1e-04	0
0.10	-1e-04	-1e-04	-1e-04	0
0.15	-1e-04	-1e-04	-2e-04	0
0.20	-1e-04	-1e-04	-2e-04	0
0.25	-2e-04	-1e-04	-2e-04	0
0.30	-2e-04	-1e-04	-2e-04	0
0.35	-2e-04	-1e-04	-3e-04	0
0.40	-2e-04	-1e-04	-3e-04	0
0.45	-3e-04	-2e-04	-3e-04	0

Oil Volatility Measure Continued

Table 8: Summary Statistics: Oil Volatility Loss Function

	Hedge Ratio	Mean	Max	Min	Std
11	0.50	-3e-04	-2e-04	-4e-04	0e+00
12	0.55	-3e-04	-2e-04	-4e-04	0e+00
13	0.60	-3e-04	-1e-04	-4e-04	0e+00
14	0.65	-3e-04	-2e-04	-4e-04	0e+00
15	0.70	-3e-04	-2e-04	-4e-04	0e+00
16	0.75	-3e-04	-2e-04	-5e-04	0e+00
17	0.80	-3e-04	-1e-04	-5e-04	0e+00
18	0.85	-3e-04	-2e-04	-5e-04	0e+00
19	0.90	-3e-04	-1e-04	-5e-04	1e-04
20	0.95	-3e-04	-1e-04	-5e-04	1e-04
21	1.00	-3e-04	-1e-04	-5e-04	1e-04

Gas Profit-Loss Function Histogram

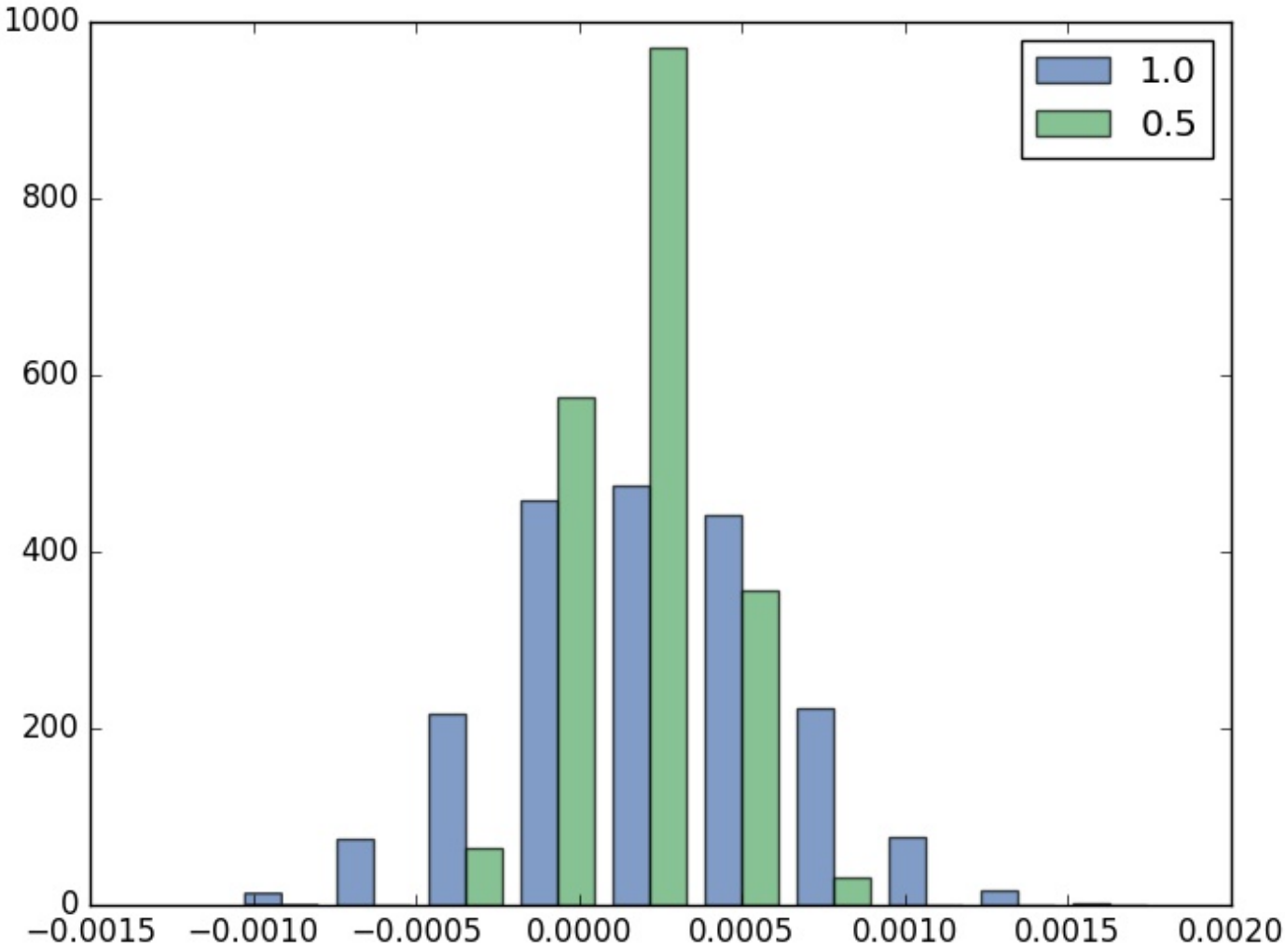

Figure 3: Bootstrapped Profit/Loss for Gasoline

Gas Volatility-Loss Function Histogram

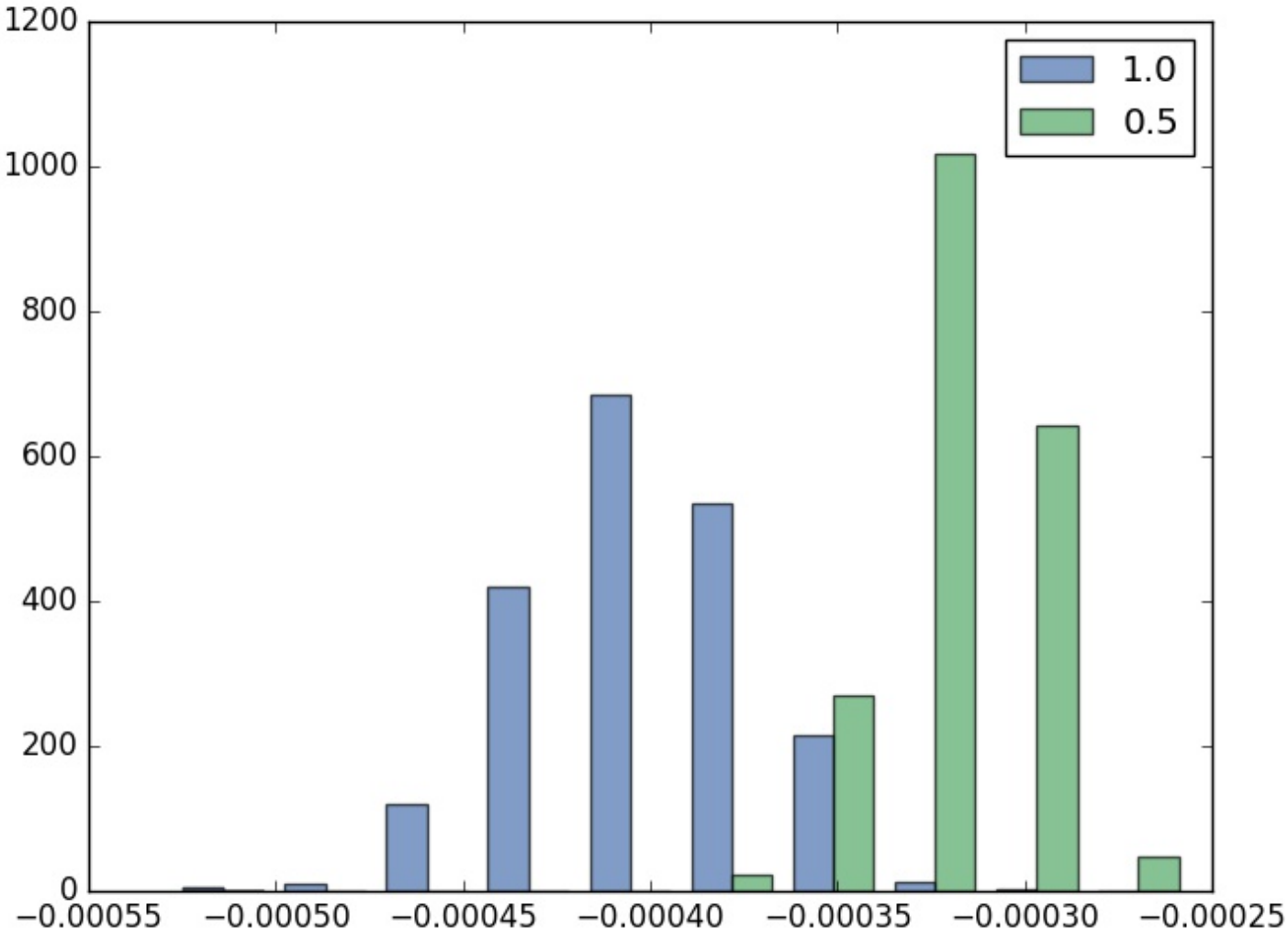

Figure 4: Bootstrapped Volatility Loss for Gasoline

Oil Profit-Loss Function Histogram

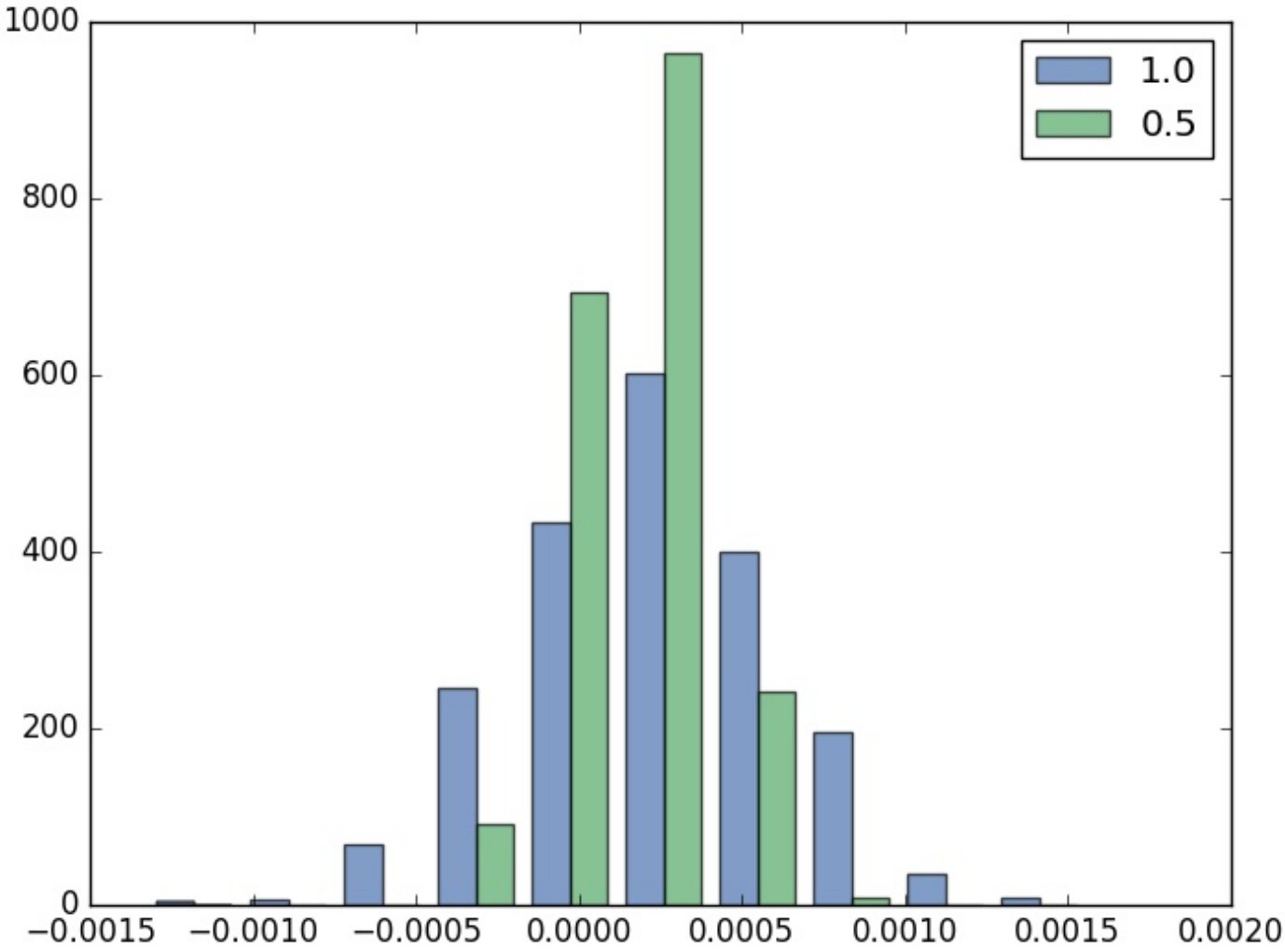

Figure 5: Bootstrapped Profit/Loss for Oil

Oil Volatility-Loss Function Histogram

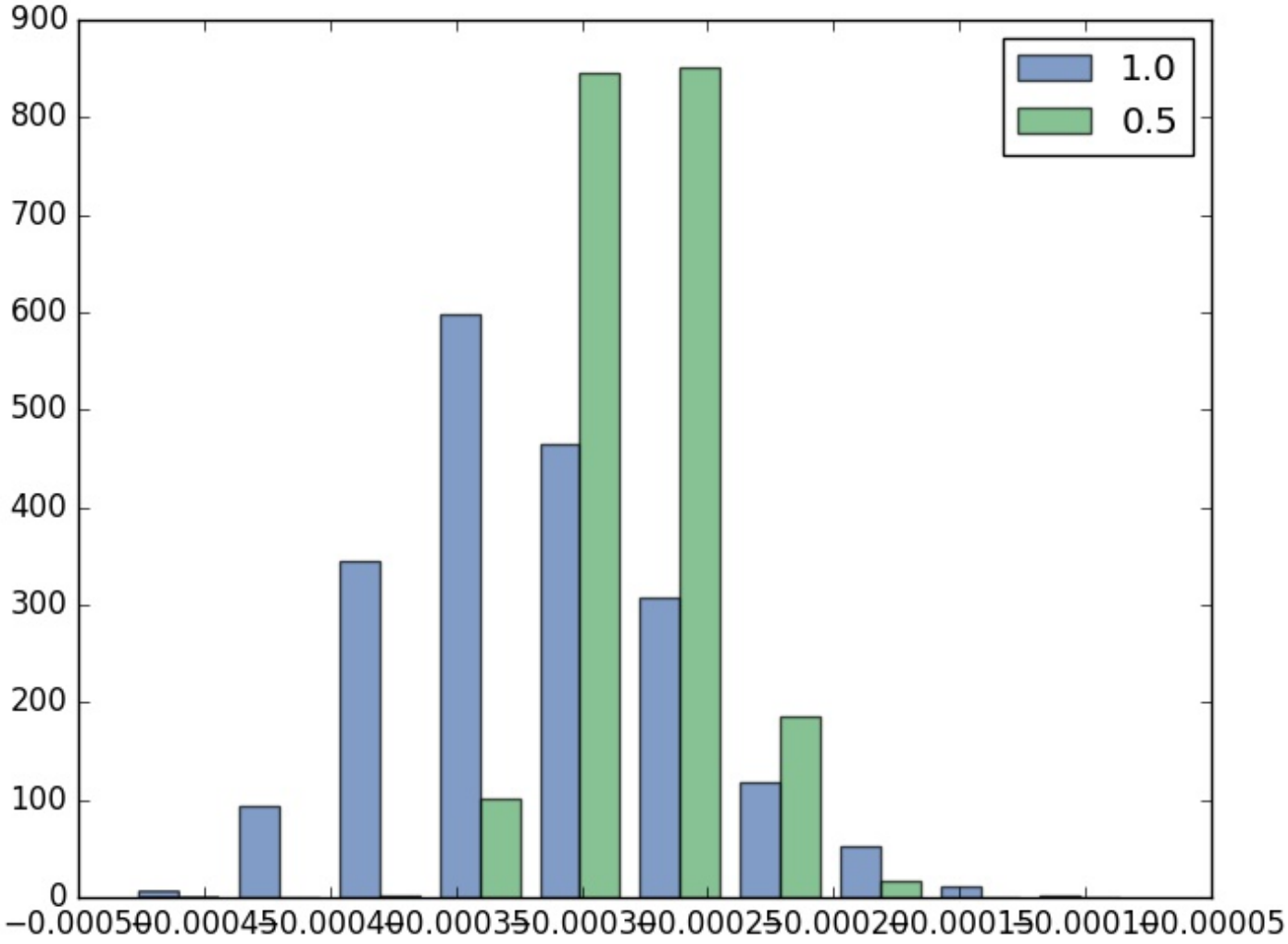

Figure 6: Bootstrapped Volatility Loss for Oil

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