



Liquidity Risk In Corporate Bond Markets

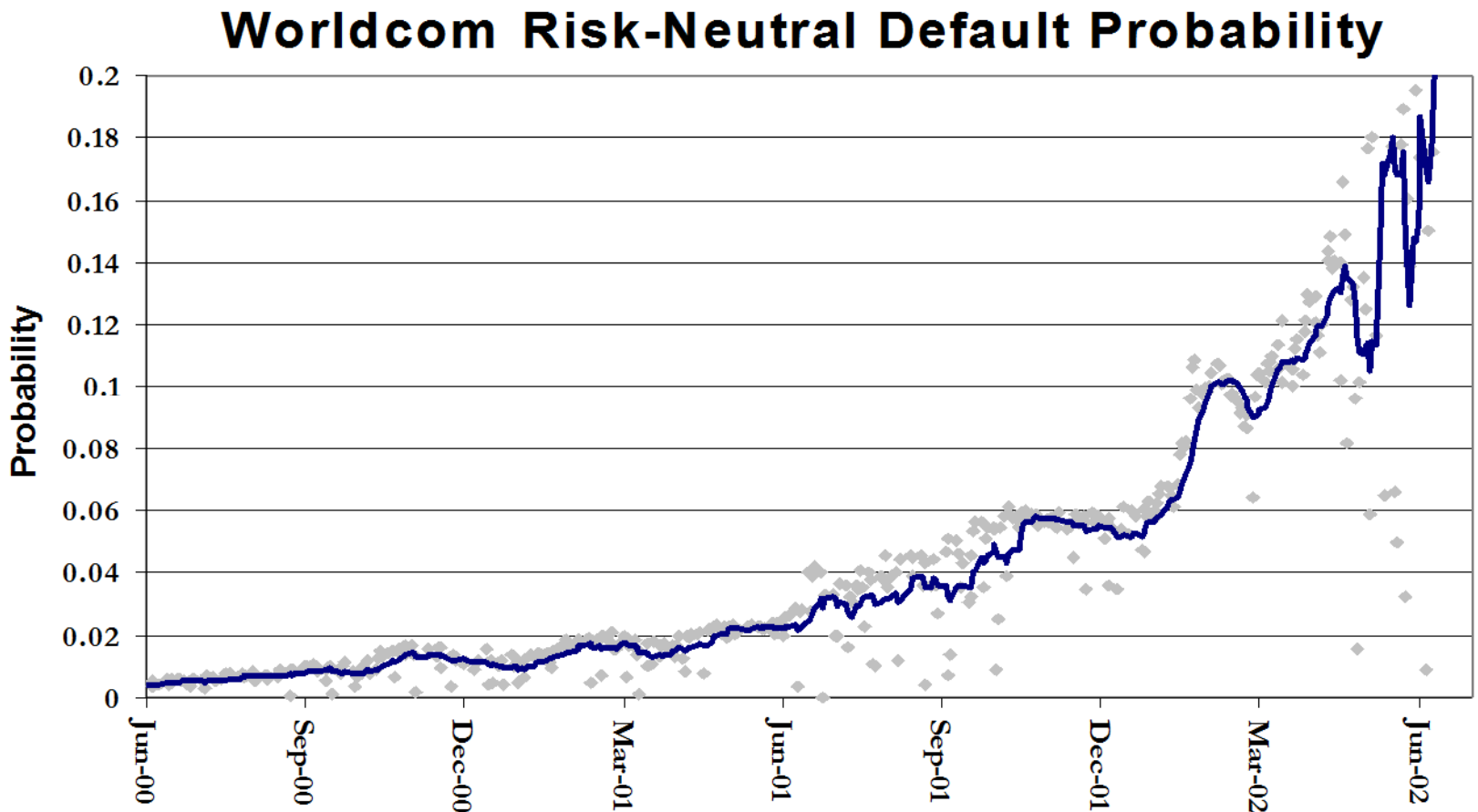
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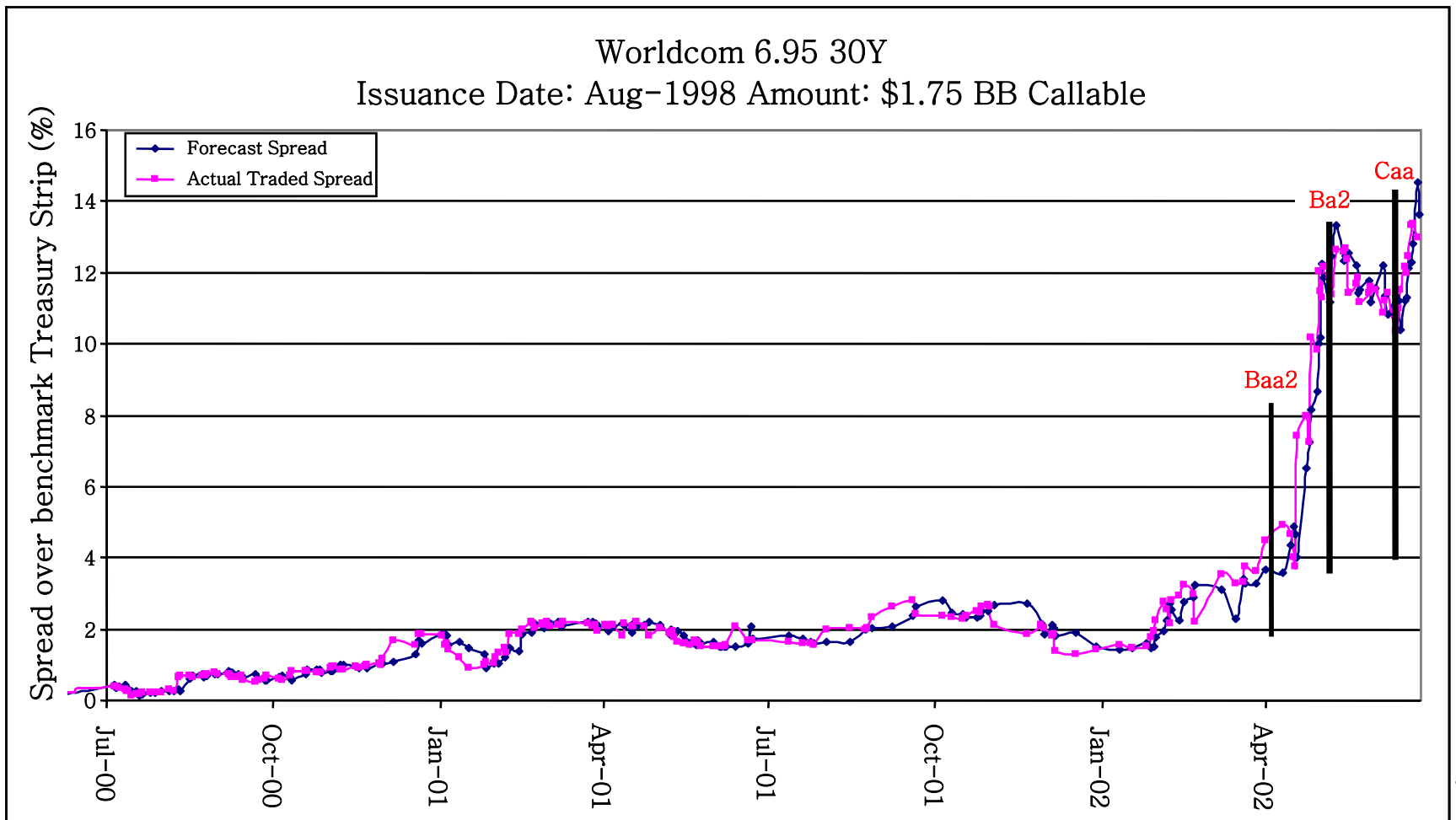
Roadmap

- Introduction
- Liquidity Risk Research
 - Motivation
 - Liquidity Measurement
 - Liquidity Factor Construction
 - Empirical Results for Liquidity Risk
 - Practical Implications of Liquidity Risk

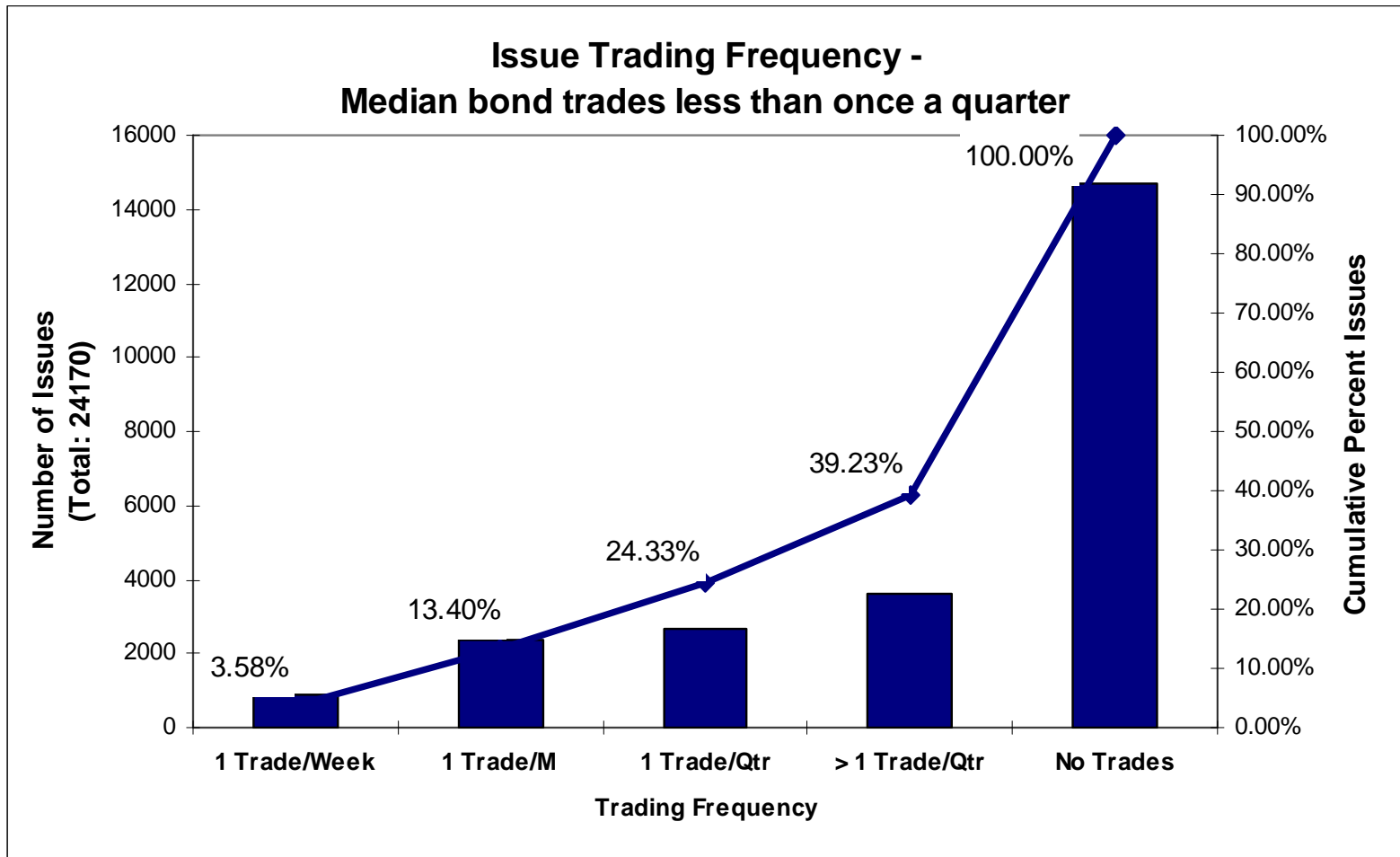
Capital Structure Arbitrage



Capital Structure Arbitrage



Corp Bond Market Liquidity





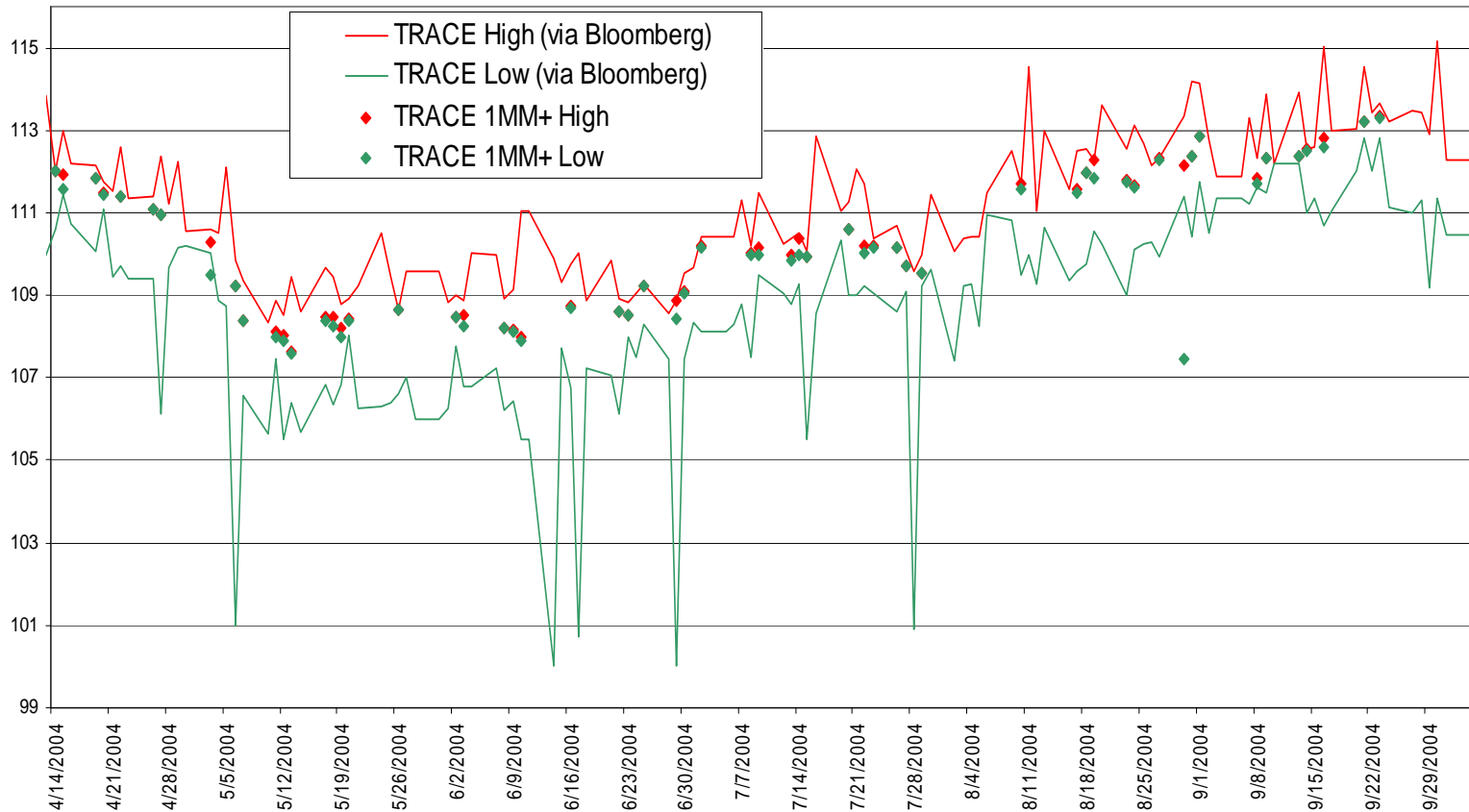
Liquidity Trend in Bond Mkt

Average Trade Size Percentiles (millions of US dollars):

| | YR94 | YR95 | YR96 | YR97 | YR98 | YR99 | YR00 | YR01 | YR02 | YR03 | YR04 |
|------------|---------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| MIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10% | 0.36 | 0.44 | 0.43 | 0.48 | 0.50 | 0.43 | 0.40 | 0.42 | 0.37 | 0.35 | 0.28 |
| 20% | 0.75 | 0.83 | 0.84 | 0.94 | 0.97 | 0.82 | 0.72 | 0.73 | 0.67 | 0.66 | 0.55 |
| 30% | 1.06 | 1.11 | 1.18 | 1.23 | 1.32 | 1.12 | 1.01 | 1.03 | 0.94 | 0.91 | 0.78 |
| 40% | 1.43 | 1.50 | 1.63 | 1.68 | 1.78 | 1.54 | 1.38 | 1.43 | 1.22 | 1.16 | 1.03 |
| 50% | 1.84 | 2.02 | 2.09 | 2.16 | 2.34 | 2.08 | 1.93 | 1.98 | 1.66 | 1.52 | 1.30 |
| 60% | 2.30 | 2.63 | 2.71 | 2.85 | 3.10 | 2.88 | 2.56 | 2.65 | 2.21 | 1.97 | 1.65 |
| 70% | 3.02 | 3.59 | 3.61 | 3.72 | 4.15 | 3.89 | 3.45 | 3.59 | 2.99 | 2.50 | 2.17 |
| 80% | 4.10 | 4.99 | 4.97 | 5.06 | 5.56 | 5.31 | 5.02 | 5.12 | 4.30 | 3.46 | 2.88 |
| 90% | 6.20 | 7.22 | 7.33 | 8.00 | 9.16 | 8.93 | 8.23 | 8.42 | 7.06 | 5.75 | 4.55 |
| MAX | 100.31 | 99.92 | 100.67 | 111.99 | 224.98 | 249.93 | 152.53 | 199.98 | 271.99 | 199.98 | 100.28 |

TRACE Comparison

CUSIP 172967BC4 (CITIGROUP), 4/14/2004 -- 10/4/2002





Limitations of Liquidity Measures

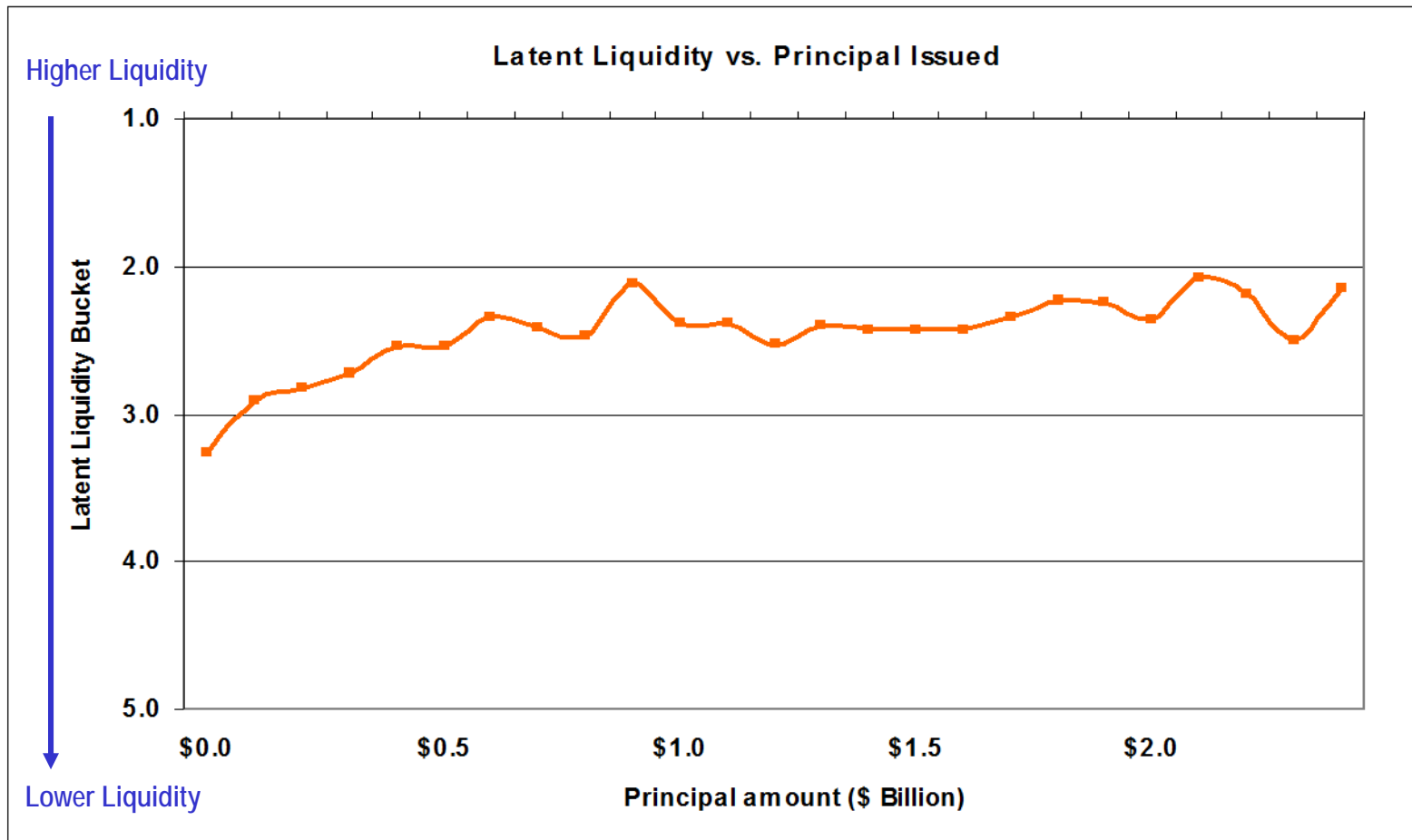
- Conventional Measures of Liquidity:
 - Trading Volume
 - Bid-Ask Spread
- However, if securities are extremely illiquid, conventional measures don't work well
- Rather than looking at actual trading, one solution is to look at a security's propensity to trade.



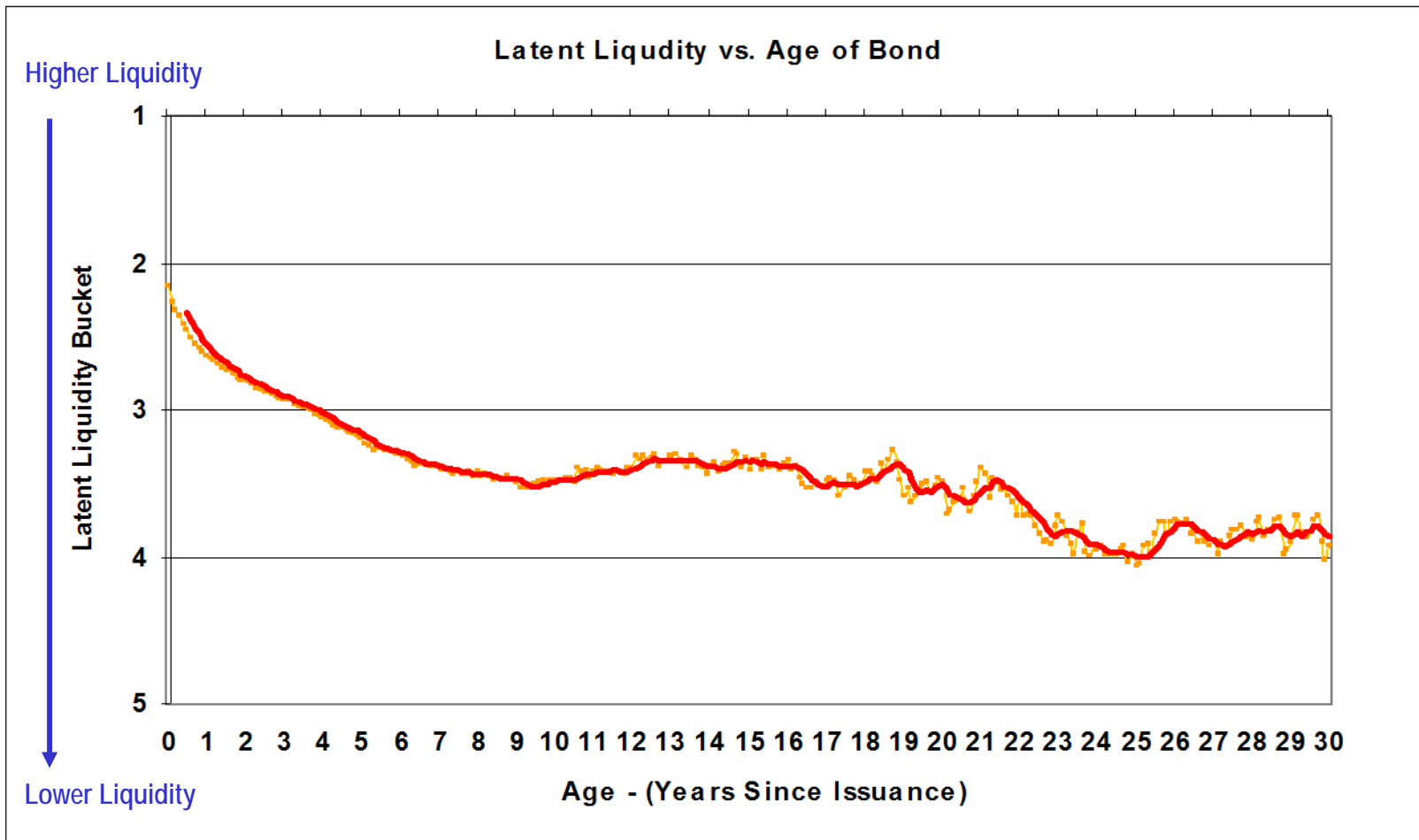
Latent Liquidity

- Latent liquidity: a quantitative measure of propensity to trade for individual securities
- Rationale:
 - For a bond dealer, it is easier to access a bond issue if it is held in high-turnover portfolios
 - If a bond issue is held by high-turnover funds, it is likely that security has a higher propensity to trade.
 - So, a security's propensity to trade can be constructed by looking at the aggregate trading characteristics of owners of that security

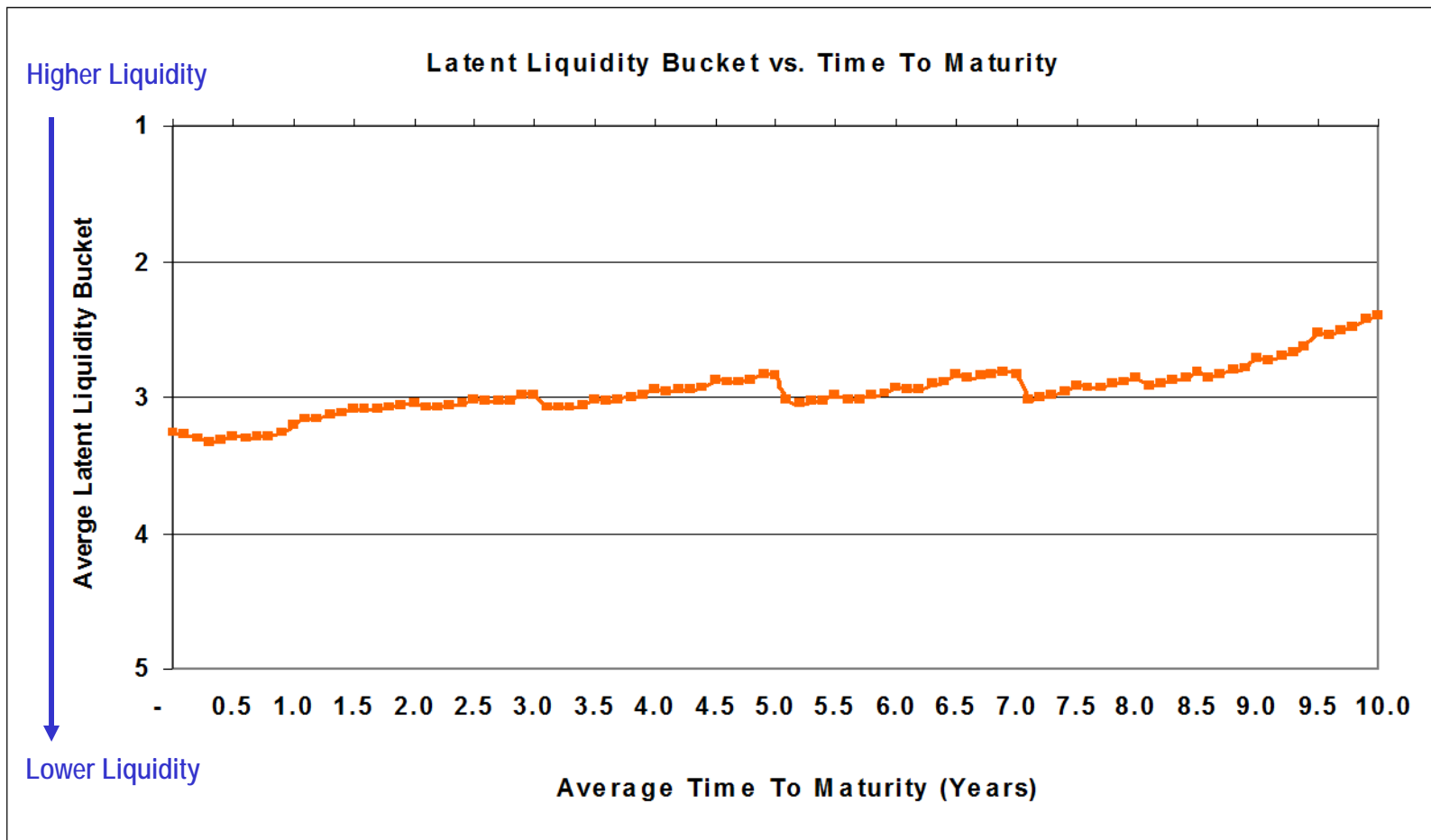
Latent Liquidity Properties



Latent Liquidity Properties



Latent Liquidity Properties

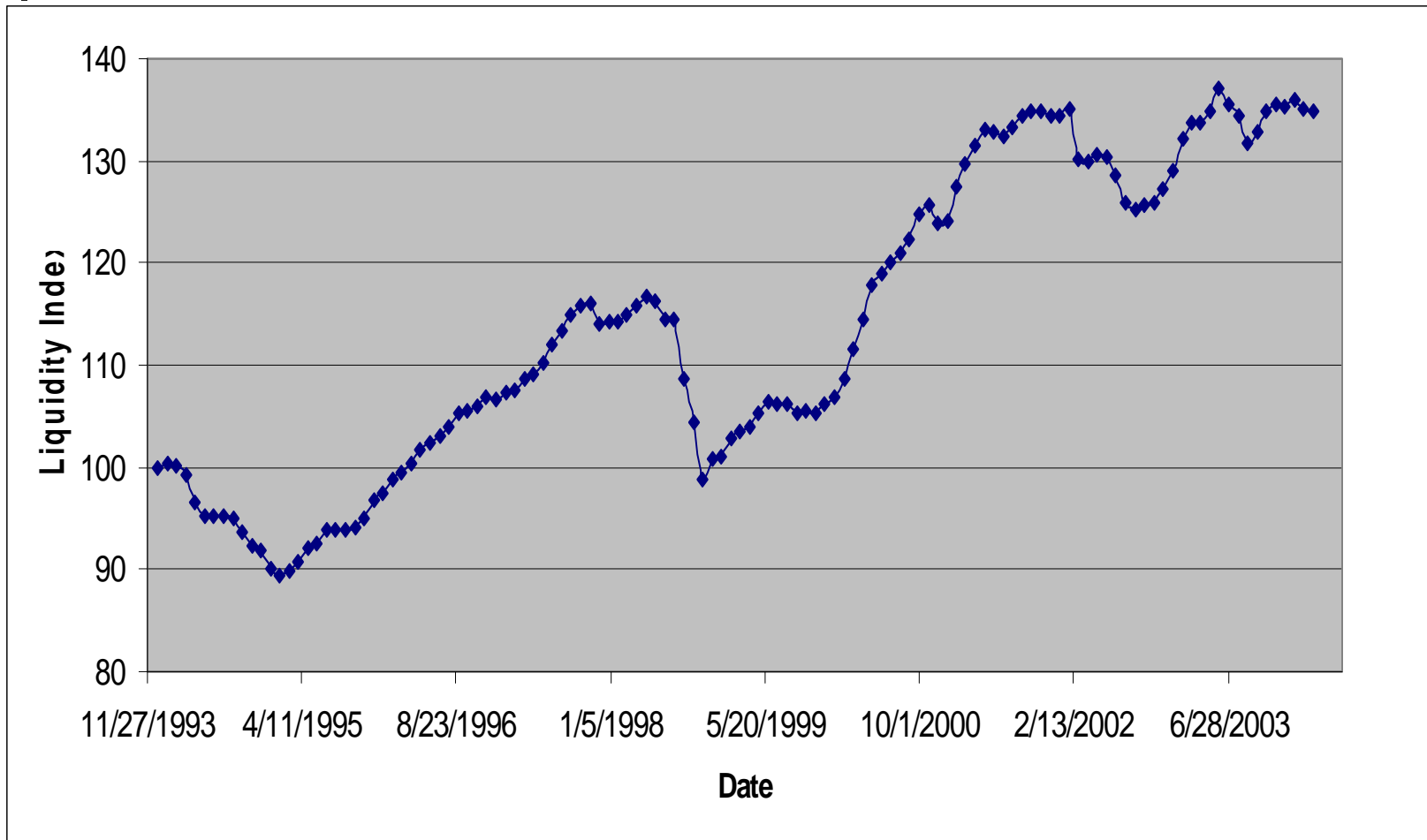




Liquidity Risk Factor Construction

- We sort the US corp bond universe into $3 \times 3 \times 3 = 27$ buckets
 - Duration
 - Credit Risk
 - Latent Liquidity
- We then form three portfolios:
 - HML Duration
 - LMH Credit Risk
 - LMH Latent Liquidity
- These portfolios represent interest rate, credit, and liquidity risk factors

Liquidity Risk Factor Time Series





Factor Regressions

- With these factors, we can now do factor regressions to compute individual security betas.
- We first compute credit, duration, and liquidity betas for the US corp bond universe.
- We then do a 5x3x3 sort of these securities based on these betas – 5 liquidity portfolios, 3 credit portfolios, and 3 duration portfolios
- Using these 45 portfolios, we then conduct a series of tests to check the importance of the liquidity risk factor.



Empirical Results

Liquidity Risk Alpha

Alphas of Portfolios Sorted on Liquidity Betas

| | L | M/L | M | H/M | H | H - L |
|------------------|--------|-------|-------|-------|-------|-------|
| CAPM | -0.54% | 0.71% | 1.25% | 1.94% | 2.36% | 2.90% |
| Duration | -0.36% | 0.69% | 1.31% | 2.13% | 2.78% | 3.14% |
| Duration, Credit | -0.56% | 0.63% | 1.09% | 1.68% | 2.15% | 2.71% |

Empirical Results

Contribution of Liquidity: 1

Incremental R^2 of Liquidity Factor

| | | Liquidity Portfolios | | | | |
|-------------------|---|----------------------|-----|-----|-----|-----|
| | | H | H/M | M | M/L | L |
| Credit Portfolios | H | 5% | 12% | 18% | 23% | 30% |
| | M | 5% | 13% | 21% | 25% | 32% |
| | L | 4% | 13% | 22% | 26% | 34% |

Empirical Results

Contribution of Liquidity: 2

Incremental R^2 of Liquidity Factor

| | | Liquidity Portfolios | | | | |
|------------------------|---|----------------------|-----|-----|-----|-----|
| | | H | H/M | M | M/L | L |
| Duration Portfolios | L | 4% | 14% | 21% | 27% | 36% |
| | M | 3% | 16% | 20% | 28% | 37% |
| | H | 6% | 17% | 23% | 30% | 39% |

Practical Implications

Convertible Arbitrage

Benchmark Regressions

| Alpha | DEF | TERM | Rm-Rf | SMB | HML | UMD | Liq. | Adj.R2 |
|--------|-------|-------|-------|------|------|-------|------|--------|
| 0.0029 | -0.66 | -0.33 | | | | | 0.27 | 0.3859 |
| 1.39 | -1.43 | -1.21 | | | | | 3.65 | |
| 0.0011 | -0.02 | 0.09 | -0.19 | 0.07 | 0.08 | -0.02 | 0.24 | 0.4897 |
| 0.59 | -0.13 | 1.1 | -2.45 | 2.45 | 1.28 | -0.09 | 2.93 | |
| 0.0012 | | | -0.19 | 0.06 | 0.1 | 0.01 | 0.26 | 0.4565 |
| 0.67 | | | -2.58 | 1.82 | 1.54 | 0.24 | 3.47 | |
| 0.0004 | -0.66 | -0.33 | | | | | | 0.055 |
| 0.58 | -1.43 | -1.21 | | | | | | |
| 0.0026 | -0.02 | 0.08 | -0.15 | 0.07 | 0.08 | -0.03 | | 0.1598 |
| 3.51 | -0.15 | 1.08 | -2.74 | 2.44 | 1.26 | -0.09 | | |
| 0.0035 | | | -0.17 | 0.06 | 0.09 | 0.01 | | 0.1566 |
| 3.32 | | | -2.07 | 1.8 | 1.51 | 0.25 | | |



Practical Implications

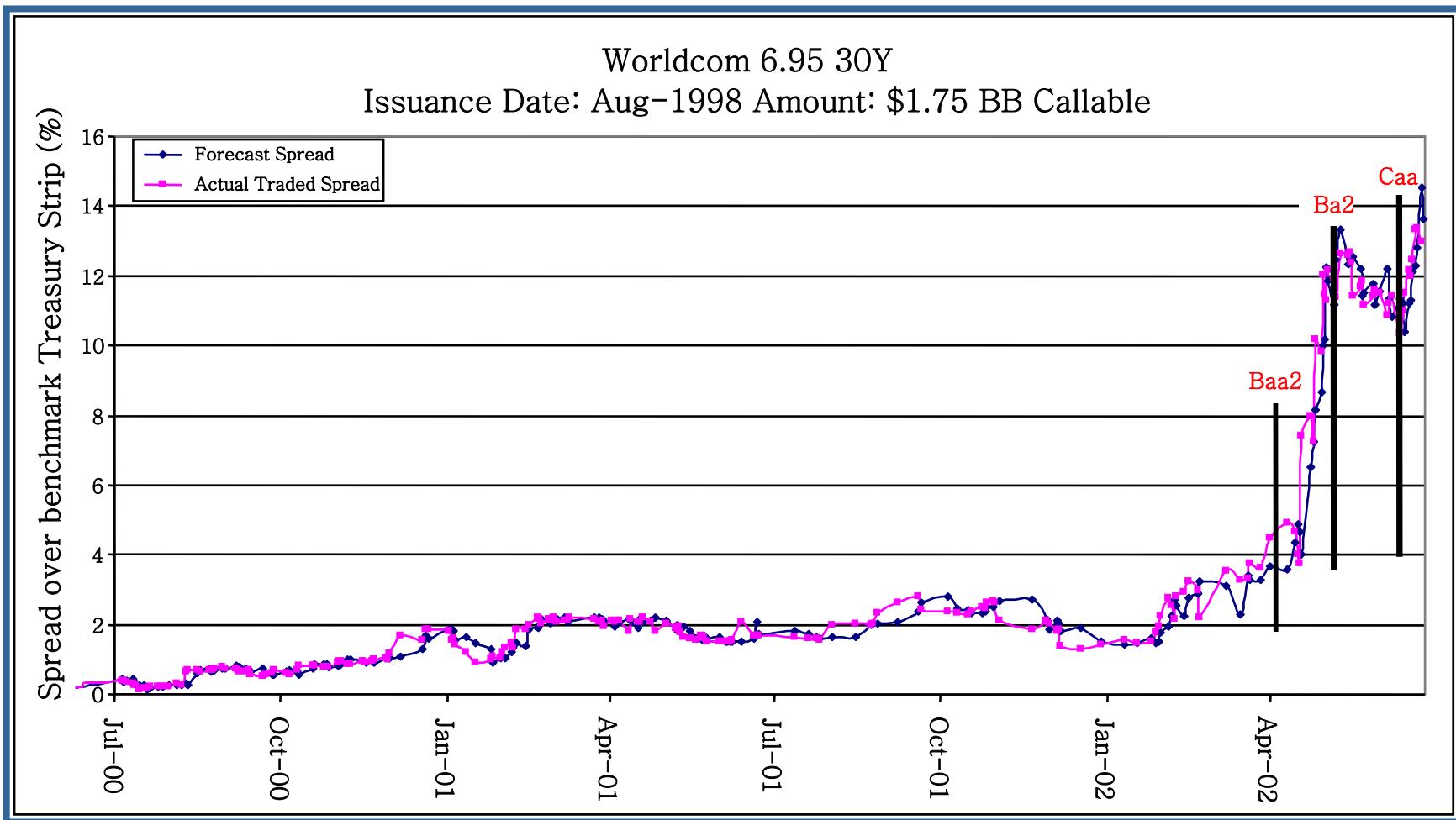
Treasury Yield Curve

Average Contribution of Factors to Bond Yields (RMSE)

| Maturity | Curvature | Term | Liquidity |
|----------|-----------|------|-----------|
| 0.5 | 2 | 3 | 5 |
| 1 | 3 | 7 | 10 |
| 2 | 7 | 9 | 16 |
| 3 | 13 | 16 | 27 |
| 5 | 29 | 37 | 56 |
| 7 | 38 | 46 | 73 |
| 10 | 21 | 64 | 97 |

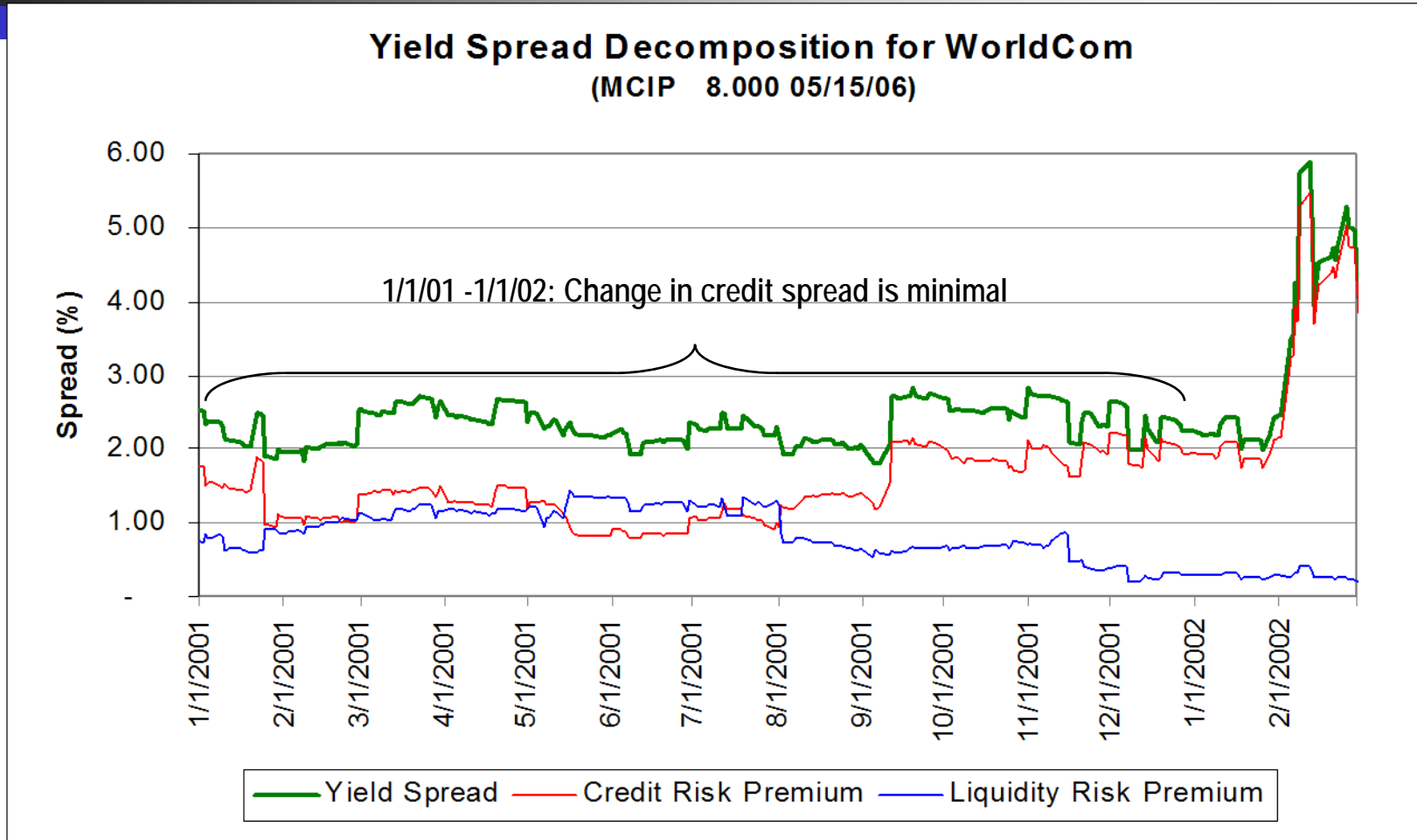
Practical Implications

Back to WorldCom



Practical Implications

Credit vs. Liquidity Spread

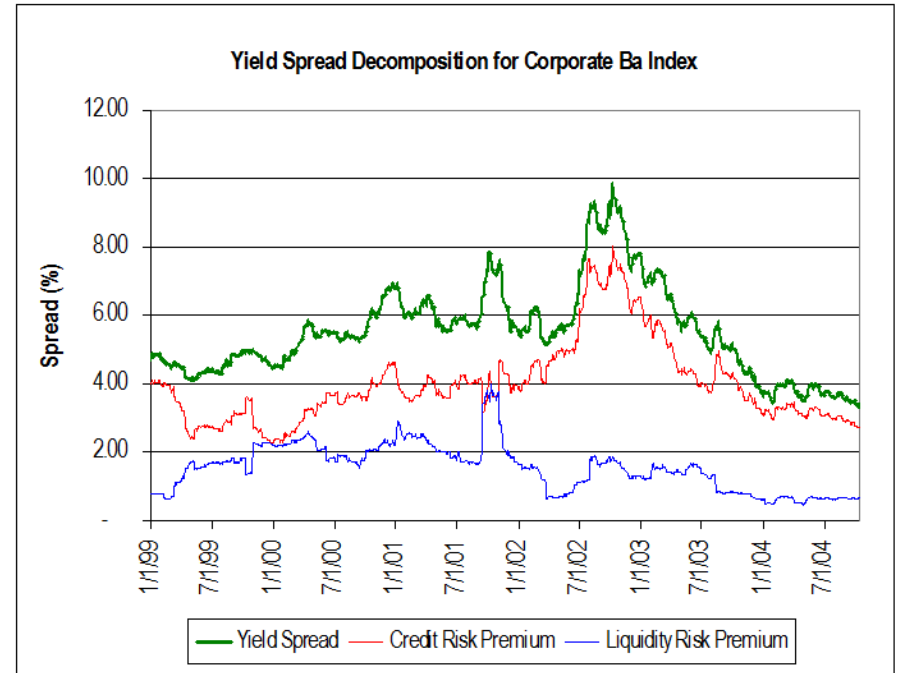
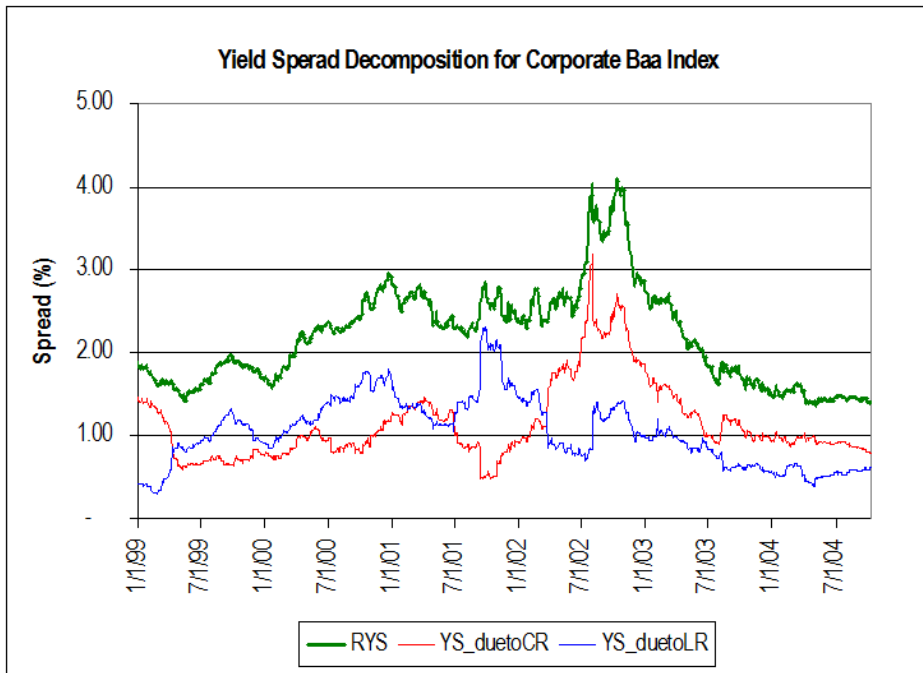


Practical Implications

Credit vs. Liquidity Spread

Baa Index

Ba Index





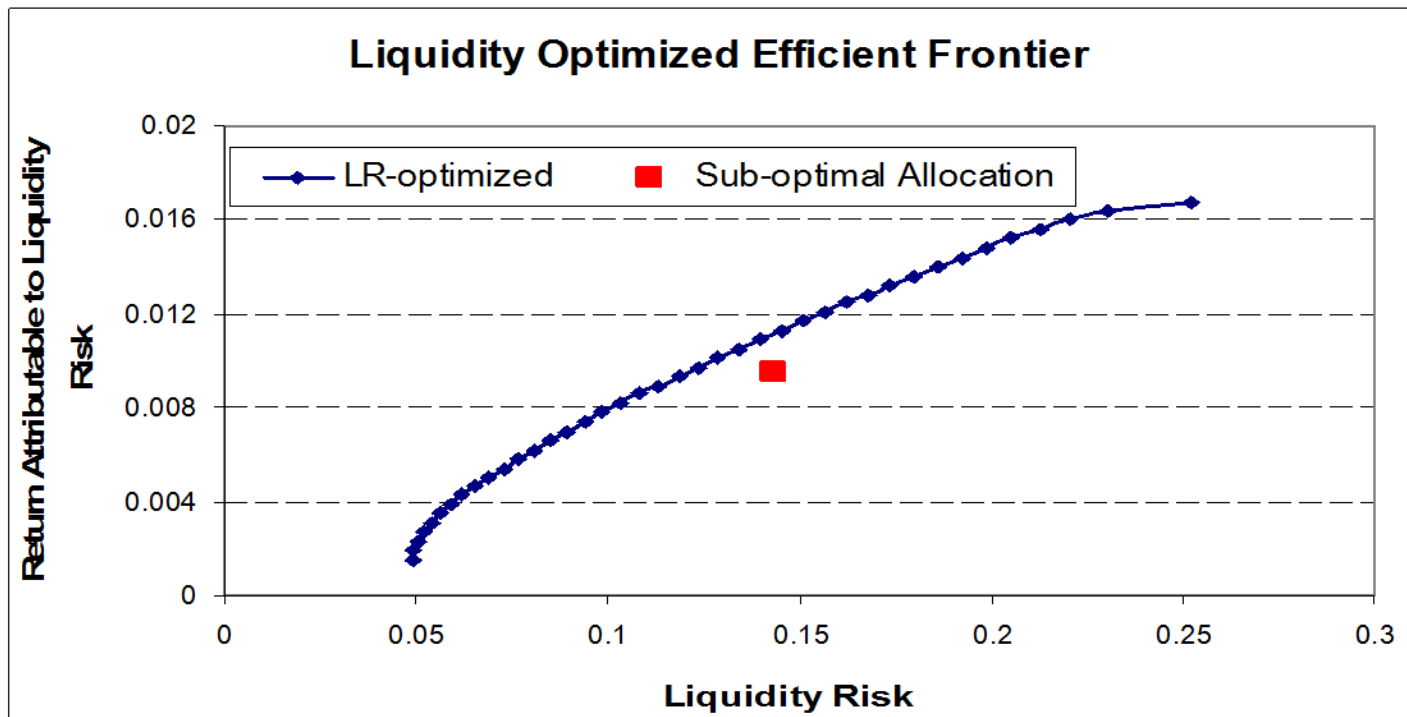
Practical Implications

Liquidity-Driven Asset Allocation

- Problem:
 - Allocate portfolio across a set of Moody's Baa1 or higher rated long duration securities.
 - Set: BLS, CAT, BA, CCE, IBM, D,ALL, WFC, PFE, SBC
- Scenarios
 - Scenario 1 (Optimizing on Total Risk)
 - Scenario 2 (Optimizing on Liquidity risk)
 - Scenario 3 (Optimizing on Credit risk)

Practical Implications

Optimizing on Liquidity Risk



Practical Implications

Optimizing on Credit Risk

