RISK ESTIMATION IN DIFFERENT FED REGIMES

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Introduction

Rising bond yields together with rising market-assigned probabilities of Federal Reserve tightening have caused some investors to express concerns regarding the stability of risk estimates. In particular, the key concern is whether historical risk measures (volatilities, correlations and covariances) provide adequate estimates of future risk, or if these measures instead tend to change depending on the market environment. The answers to these questions have profound implications for the use investors make of risk models. If risk estimates are unstable between various market environments, investors may need to recalibrate their risk models for use under different market conditions. Alternatively, if covariance matrices across different regimes are similar, investors can (and should[1]) use a single risk model estimated across multiple regimes. We also examine the implications of our conclusions for risk–adjusted portfolio performance.

Outline of Empirical Study

Many possible choices exist for delineating market regimes. These include defining regimes in terms of recession versus boom[2] or in terms of rising and falling treasury yields[3]. We chose instead to delineate market regimes in terms of Federal Reserve policy stance. Each market regime is defined by movements in the Federal Funds target rate. An easing/tightening period is defined as the month following the first decrease/increase in the target rate, until the month during which the last decrease/increase took place. A third "interregnum period" is defined as the time between easing and tightening periods. For our study we examined monthly returns data for the period August 1988 – July 2003 for various asset classes. These returns were grouped into one of three Fed funds regime categories depending on the movement of the Fed Funds target rate as illustrated in Figure 1. Corresponding annualized volatilities and correlations were calculated for each regime, as illustrated in Figures 2-5.

Excess Returns

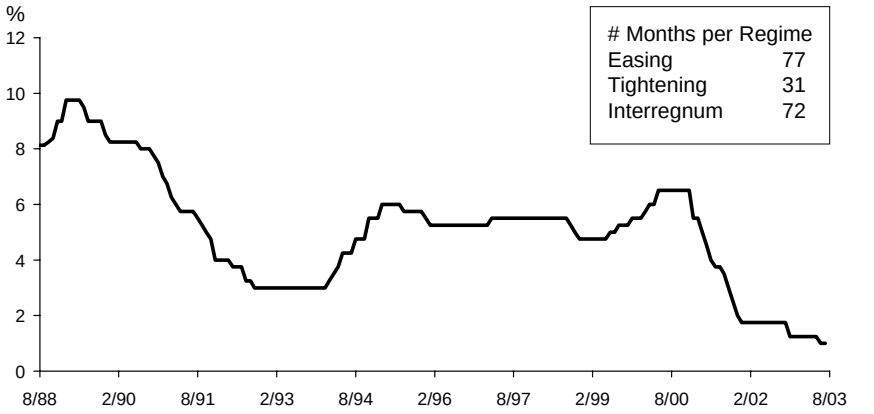
With the exception of treasuries, German government bonds and G6 currencies (where we used total returns), we used volatilities and correlations of excess returns. Prior to 2001, Lehman Brothers computed excess returns using a duration bucket approach, partitioning each spread security's duration exposure into semi-annual duration buckets. Beginning in 2001, Lehman Brothers has been computing excess returns by matching each security's key rate duration (KRD) profile to a corre-

[1] It will be much easier, and statistically more significant, to use a single covariance matrix, rather than two or more matrices computed with smaller data sets.

[2] Recessions and booms are sometimes declared with substantial lags, for example the National Bureau of Economic Research, the "official" arbiter of recessions, declared in July 2003 that the trough in the recession occurred in November 2001. The "economists' rule", defining a recession as two consecutive quarters of negative growth, is also undesirable from an analytical perspective, owing to the sometimes large revisions in GDP data. For example, real GDP growth for Q2 2001, originally reported as +2.0%, was revised in July 2002 to –0.6%.

[3] Treasury yields are market determined, endogenous variables, and therefore less appropriate for regime definitions, than changes in the Fed. Funds rate.

Figure 1. **Federal Reserve Regimes,** "Fed Funds Target Rate"



sponding treasury security. This technique is necessary to capture the duration exposure of securities with embedded optionality[4]. Therefore, for this study, the calculation of volatilities and correlations is a result of the combination of both excess return methods.

The Results

Before examining the results, investors should note the relative paucity of monthly returns series within each of the Fed regimes used to generate the correlation and covariance matrices. However, we believe these results do highlight important differences between regimes. While the sample size for the tightening regime is relatively small, we would derive similar conclusions in the analysis that follows from examining only the easing and interregnum regimes, which have significantly larger samples.

We illustrate the annualized volatilities and correlations of monthly returns between asset classes in Figures 2 – 5, using total returns for treasuries, German government bonds, and G7 currencies, and excess returns for all other asset classes. Overall, it is notable that return volatilities are substantially lower during periods of Fed tightening and interregnum periods, than during periods of Fed easing, with the exception of Agencies (higher)[5] and MBS (virtually unchanged). This is particularly pronounced in the credit sectors – the volatility of high yield and BBB excess returns is more than twice as great during periods of Fed easing. The correlations between high yield and other credit sectors are higher during periods of Fed easing. For example the correlations between high yield excess returns and investment-grade corporates is 0.80 during easing periods, and 0.63 during tightening periods. These findings are in line with our intuition that Fed easing generally accompanies a slowing economy, and hence, deteriorating credit quality (witness this most recent

[4] For further details of the computation of excess returns, See "A New Method of Excess Returns Computation" , Lehman Brothers, in Global Relative Value, September 2000.

[5] The higher volatility of agency excess returns may be due to their strong correlation with swap spreads. In a tightening environment, with short rates rising and yield curves flattening, borrowers are enticed to pay fixed and receive floating, increasing the volatility and level of swap spreads, and hence agency spreads.

Figure 2. **Asset Class Volatilities* Under Different Regimes (% p.a.)**
(August 1988- July 2003)

	Easing	Tightening	Interregnum
Corporate	2.75%	1.35%	1.50%
Corp Aa-Aaa	1.61	1.09	1.13
Corp A	2.58	1.39	1.33
Corp Baa	4.07	1.93	1.96
MBS	1.27	1.39	1.35
G6 (ex-US)	8.75	8.24	7.45
Agency	0.46	0.77	0.60
High yield	10.71	4.26	5.93
German Govt.	3.45	3.14	3.17
US 10 yr. UST	10.62	9.45	9.82

*Volatilities are shown for excess returns, except for G6 (currency returns), and US treasury and hedged German government bond returns (total returns).

Correlations of excess returns of major asset classes, credit index quality sub-components, and currency returns of G6 countries (USD terms), total returns of hedged-USD German government bonds, and 10-year U.S. Treasury notes

Figure 3. **Easing Regime**

	Corporate	Corp Aa-Aaa	Corp A	Corp Baa	MBS	G6 Currency	Agency	High Yield	GermanTSY	US 10Y
Corporate	1.000	0.921	0.968	0.974	0.329	-0.267	0.350	0.804	-0.146	-0.448
Corp Aa-Aaa	0.921	1.000	0.903	0.860	0.430	-0.316	0.428	0.722	-0.096	-0.469
Corp A	0.968	0.903	1.000	0.903	0.334	-0.278	0.325	0.758	-0.114	-0.432
Corp Baa	0.974	0.860	0.903	1.000	0.312	-0.276	0.346	0.817	-0.156	-0.435
MBS	0.329	0.430	0.334	0.312	1.000	-0.208	0.425	0.265	-0.113	-0.255
G6 Currency*	-0.267	-0.316	-0.278	-0.276	-0.208	1.000	-0.091	-0.281	0.078	0.284
Agency	0.350	0.428	0.325	0.346	0.425	-0.091	1.000	0.236	0.012	-0.225
High Yield	0.804	0.722	0.758	0.817	0.265	-0.281	0.236	1.000	-0.147	-0.478
German TSY**	-0.146	-0.096	-0.114	-0.156	-0.113	0.078	0.012	-0.147	1.000	0.252
US 10Y***	-0.448	-0.469	-0.432	-0.435	-0.255	0.284	-0.225	-0.478	0.252	1.000

Figure 4. **Tightening Regime**

	Corporate	Corp Aa-Aaa	Corp A	Corp Baa	MBS	G6 Currency	Agency	High Yield	GermanTSY	US 10Y
Corporate	1.000	0.930	0.965	0.951	0.429	0.025	0.777	0.626	-0.266	-0.395
Corp Aa-Aaa	0.930	1.000	0.920	0.806	0.534	-0.012	0.840	0.506	-0.174	-0.322
Corp A	0.965	0.920	1.000	0.868	0.373	-0.069	0.763	0.639	-0.348	-0.431
Corp Baa	0.951	0.806	0.868	1.000	0.318	0.100	0.644	0.597	-0.232	-0.367
MBS	0.429	0.534	0.373	0.318	1.000	-0.162	0.684	0.192	0.081	0.314
G6 Currency*	0.025	-0.012	-0.069	0.100	-0.162	1.000	-0.294	-0.075	0.049	-0.191
Agency	0.777	0.840	0.763	0.644	0.684	-0.294	1.000	0.472	-0.013	-0.084
High Yield	0.626	0.506	0.639	0.597	0.192	-0.075	0.472	1.000	-0.503	-0.482
German TSY**	-0.266	-0.174	-0.348	-0.232	0.081	0.049	-0.013	-0.503	1.000	0.352
US 10Y***	-0.395	-0.322	-0.431	-0.367	0.314	-0.191	-0.084	-0.482	0.352	1.000

Figure 5. **Interregnum Regime**

	Corporate	Corp Aa-Aaa	Corp A	Corp Baa	MBS	G6 Currency	Agency	High Yield	GermanTSY	US 10Y
Corporate	1.000	0.889	0.987	0.973	0.399	-0.070	0.371	0.732	-0.257	-0.261
Corp Aa-Aaa	0.889	1.000	0.901	0.795	0.523	-0.076	0.595	0.514	-0.113	-0.133
Corp A	0.987	0.901	1.000	0.951	0.408	-0.062	0.354	0.710	-0.255	-0.264
Corp Baa	0.973	0.795	0.951	1.000	0.361	-0.041	0.278	0.747	-0.290	-0.255
MBS	0.399	0.523	0.408	0.361	1.000	-0.109	0.495	0.266	-0.153	-0.101
G6 Currency*	-0.070	-0.076	-0.062	-0.041	-0.109	1.000	-0.048	-0.087	-0.024	0.058
Agency	0.371	0.595	0.354	0.278	0.495	-0.048	1.000	0.029	0.132	0.121
High Yield	0.732	0.514	0.710	0.747	0.266	-0.087	0.029	1.000	-0.332	-0.363
German TSY**	-0.257	-0.113	-0.255	-0.290	-0.153	-0.024	0.132	-0.332	1.000	0.388
US 10Y***	-0.261	-0.133	-0.264	-0.255	-0.101	0.058	0.121	-0.363	0.388	1.000

period of Fed easing). This in turn is the dominant factor driving returns, which increases correlations across credit categories.

The correlation between the excess return on mortgage-backed securities and the total return on ten-year US treasuries changes sign, from negative during easings, to positive during tightenings. This, again, is an intuitive result, reflecting the negative convexity of mortgages. Excess returns are negative in both periods, and are therefore correlated negatively with falling treasury yields in periods of Fed easing, and correlated positively with rising treasury yields during periods of Fed tightening.

Less intuitive is the volatility of returns during the interregnum periods. By our definition these are periods of regime shift, from tightening to easing, or vice-versa, which might have been expected to have produced greater volatility, due to the greater uncertainty of future Fed actions. However, our findings show that, in most cases, volatilities are as low as for the Fed tightening regime.

Looking at foreign bond and currency exposures, the return volatilities of hedged German bonds do not show a notable difference between regimes, and return correlations to US treasuries remain little changed. The volatilities and correlations of the currency return component of the Lehman G6 (G7 ex-US) Treasury Index are also little changed between regimes, though falling somewhat in the interregnum periods. Intriguingly this is not the case for the correlations of currency returns with US credit sectors. (See below for further discussion)

Implications for Portfolio Managers

Correlations are often used by managers to understand the strength of the relationship between assets, but say nothing about their volatilities. In order to estimate portfolio risk and tracking error, we must use covariances, a product of the correlation between two asset returns and their standard deviations. The covariance matrices included in Figures 7-8 demonstrate that covariances tend to fall in absolute terms during Fed tightenings, relative to Fed easings. The fall in covariances is most pronounced for high yield, largely a function of the substantial fall in volatility of high yield excess returns between regimes. This also reflects the high absolute volatility of high yield compared to other asset classes. The percentage fall in covariances is little different from that of other asset classes. Currency exposure exhibits a strongly negative covariance with high yield returns during easing regimes, and a smaller negative covariance during tightening regimes. This suggests that currency exposure has the desirable property of reducing the contribution of high yield to total portfolio volatility, at the time it is most needed, having a lesser impact when it is less needed.

These matrices also suggest that a risk model calibrated across different regimes will tend to overestimate risk during Fed tightenings and underestimate risk during Fed easings. This indeed has been our experience with the Lehman Brothers Multi-Factor Risk Model. As a result, we now offer investors a choice of weighting schemes for the covariance matrix to use in our risk model. By selecting a weighted matrix, data is exponentially weighted with a one-year half life, allowing for the more recent past to be relatively quickly incorporated into the estimate of tracking error. If the

period of Fed easing is now behind us (as many market participants have apparently concluded), the risk model can be expected to overestimate portfolio tracking-error over coming months, a trait that is preferable to underestimating risk. This period will also allow us some time to consider whether to offer a recalibrated "easing regime matrix" in time for the next period of easing.

A further important conclusion of this analysis is that managers should be able to achieve higher information ratios during Fed tightenings than during Fed easings. Since covariances between asset classes are generally lower during periods of rising short-term interest rates, managers should be able to achieve the same level of outperformance with a lower overall tracking error. Additionally, the lesser importance of the cash constraint for real money investors during bear markets should allow for greater outperformance from curve positioning in bear relative to bull markets[6].

Examining the Impact of Regimes on Predicted Information Ratio

We can test the proposition that investors should be able to achieve higher information ratios during Fed tightenings, by using the risk budgeting framework we introduced in a previous paper[7]. We construct separately two portfolios which maximized ex-ante information ratios, constrained to prohibit short positions, with tracking error budgets of 150bp per annum. One portfolio was constructed using the Fed easing covariance matrix, and the other using the Fed tightening matrix, with identical skill levels (15%) assigned to all active positions[8]. The exposures are shown in Figure 6.

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[6] In a bear market, the optimal curve exposure is generally a lower-than-index duration, with a barbell to benefit from yield curve flattening. In a bull market, the optimal exposure is generally a higher-than-index duration with a bullet, a structure that cannot easily be achieved by cash-constrained investors. For further details of the cost of this constraint, see "Cost of the no-leverage constraint in duration timing", Lehman Brothers, October 2002.

[7] "Value of Skill in Macro Strategies for Global Fixed Income Investing", Lehman Brothers, May 2003

[8] Skill is defined as the ability to select a winning strategy (i.e. be long or short), where the probability of a successful trade is equal to 50% + (1/2 * skill level). Ibid for further information.

Figure 6. **Optimal Portfolio Active Exposures for a Lehman Aggregate Benchmarked Portfolio**

	Fed Easing Covar. Matrix		Fed Tightening Covar.Matrix	
Exposure	**Active Position**	**Total Position**	**Active Position**	**Total Position**
Maturity 1-3 year	5.14%	23.18%	5.14%	23.18%
Maturity 3-7	0.00	17.40	0.00	17.40
Maturity 7-10	-10.96	0.00	-10.96	0.00
Maturity 10+	5.82	20.92	5.82	20.92
Inv. Grade Credit	0.00	27.46	0.00	27.46
MBS	21.77	55.94	19.90	54.07
Agency	-12.16	0.00	-12.16	0.00
ABS/CMBS	0.90	5.23	0.72	5.05
High Yield	2.82	2.82	4.55	4.55
EUR Governments	8.54	8.54	8.88	8.88
Ex-ante information ratio		**0.66**		**0.90**

Since identical skill levels are assigned for all strategies in each regime, the changes in allocations reflect only the differences in volatilities and correlations between regimes. As predicted, the information ratio is substantially greater in a tightening environment.

Conclusions

Our results suggest that volatilities and correlations are lower during Fed tightening cycles than during easing cycles. This should enable managers to achieve higher information ratios in an environment of rising short-term interest rates. Moreover, risk models that estimate across different regimes will tend to over-estimate tracking error during periods of Fed tightening and underestimate during Fed easings. In the current environment, investors should be mindful of the likelihood that risk is being overestimated. This can be mitigated by choosing to use an exponential weighting methodology, as a change to a new Fed regime is confirmed. The use of separate covariance matrices specified over different regimes is an alternative deserving of further research.

Our definition of regimes was designed to be objective and verifiable, and to demonstrate the differences between regimes. However, it is not a definition which would be verifiable in real time. For example, at the current time, how do we know whether we are still in an easing cycle or in an interregnum period? The answer is that we do not. Managers presented with a choice of three matrices would need to make that determination themselves. We could have eliminated any subjectivity by redefining the regimes, eliminating the interregnum definition. All monthly data would then have been assigned to one of two groups (tightening or easing) depending on the most recent Fed action. The choice of matrix would then be entirely automatic, but almost certainly at the expense of reducing the forecasting accuracy of the matrix. The question as to whether covariance matrices should be constructed and chosen to eliminate subjectivity or to maximize accuracy is one that we will leave to our readers, for the moment anyway.

Covariance Matrix of Selected Asset Classes

Figure 7. **Federal Easing**

	UST 10-Yr	Corporate	High Yield	MBS	Agency	G6 Ccy.
UST 10-Year	9.270	-1.077	-4.466	-0.284	-0.091	2.170
Corporate	-1.077	0.624	1.951	0.095	0.037	-0.530
High Yield	-4.466	1.951	9.433	0.298	0.096	-2.160
MBS	-0.284	0.095	0.298	0.134	0.021	-0.190
Agency	-0.091	0.037	0.096	0.021	0.018	-0.030
G6 Currency	2.170	-0.530	-2.160	-0.190	-0.300	6.300

Figure 8. **Federal Tightening**

	UST 10-Yr	Corporate	High Yield	MBS	Agency	G6 Ccy.
UST 10-Year	7.203	-0.405	-1.566	0.333	-0.049	-1.200
Corporate	-0.405	0.146	0.289	0.065	0.065	0.020
High Yield	-1.566	0.289	1.464	0.091	0.125	-0.210
MBS	0.333	0.065	0.091	0.156	0.059	-0.150
Agency	-0.049	0.065	0.125	0.059	0.048	-0.150
G6 Currency	-1.200	0.020	-0.210	-0.150	-0.150	5.470