HEDGING CORPORATE BOND PORTFOLIOS ACROSS THE BUSINESS CYCLE

ALAN J. MARCUS AND EVREN ORS

This article reconsiders the problem of hedging portfolios of corporate bonds. It extends earlier work by demonstrating empirically that hedge ratios vary systematically over the course of the business cycle in patterns that make good intuitive sense. The empirical results also indicate that the market perceives the credit risk of bonds of a given rating class to vary systematically over the business cycle, despite the fact that the level of credit risk ascribed to each rating class by the rating agencies is not explicitly time-varying.

We adopt the approach of Grieves [1986], who demonstrates that portfolios of corporate bonds that are subject to default risk can be more effectively hedged when stock index futures are included with Treasury bond futures in the menu of hedging instruments. The fact that default risk gives corporate bonds an implicit equity component is well-known and has ample empirical support.

For example, Weinstein [1985] demonstrates that investment-grade corporate bonds have positive stock market betas, and Cornell and Green [1992] find that low-grade bond mutual funds have significant stock market betas exceeding those of investment-grade funds.

This research has obvious implications for managers who wish to hedge bond portfolios. For example, Grieves finds that when both Treasury bond and stock index futures are used to hedge investment-grade bond portfolios, the optimal hedge ratio on the stock index futures contract increases steadily, while the hedge ratio on the T-bond futures contract decreases steadily as the rating class of the bond portfolio declines. These results make sense: The greater default

ALAN J. MARCUS is professor of finance at the Wallace E. Carroll School of Management at Boston College in Chestnut Hill, Massachusetts.

EVREN ORS is a Ph.D. candidate at the Wallace E. Carroll School of Management at Boston College.

risk of the lower-rated bonds should give them a greater equity component, and consequently more exposure to macroeconomic conditions that are captured by movements in the stock index.

At the same time, the lower hedge ratios of lower-rated bonds on the T-bond contract can be attributed in part to yield premiums for default risk that result in lower duration. In addition, to the extent that hedge ratios on the stock index futures are higher for lower-rated bonds while stock index returns themselves respond to interest rate fluctuations, some of the interest rate exposure of lower-rated bonds is already hedged by the position in the stock index contract. These results confirm that hedging applications such as immunization strategies using corporate bonds must account for the equity exposure of the underlying portfolio.

Grieves's study raises another question: Are the hedge ratios for corporate bonds stable across the business cycle? One might expect that in periods of recession or low confidence, when default risk seems more important, the market sensitivity of bonds should be higher. While this conclusion is consistent with theory, it has been surprisingly difficult to confirm empirically.*

In this article, we measure hedge ratios for bonds of various rating categories, and, in particular, examine their behavior across the business cycle. Some of our results are not surprising. We find that returns on lower-rated bonds are more sensitive to the equity market than higher-rated bonds, and that this sensitivity is greater during periods of low confidence. Some of our results, however, are more surprising.

For example, we find that in periods of high confidence, bond returns across all rating classes in our sample show little sensitivity to the market index; their betas are uniformly near zero. Differences in market sensitivity during downturns, however, are significant.

Our tests also provide an interesting perspective on the behavior of bond rating agencies. If one takes the descriptions of each bond rating class literally, then even as economic conditions change, default risk for that class should be relatively constant.

For example, if the default risk of a Baa-rated bond increases substantially in a recession, the bond should be downgraded, leaving the credit risk of the Baa-rating class unchanged. In this case, the beta of each rating class will be approximately constant across the business cycle.

On the other hand, if the rating agencies are averse to making frequent upgrades and downgrades as the economy waxes and wanes, then the average credit risk of each rating class will vary systematically across the business cycle; such variation is consistent with the pattern that we document below. This suggests that the credit criteria for each rating class seem to be at least a bit "elastic" across the business cycle.

I. EMPIRICAL PROCEDURES

We calculate hedge ratios by regressing bond rates of return on the percentage changes in the futures prices of the S&P 500 and the Treasury bond contracts. The regression coefficients indicate the combination of futures contracts that most closely tracks the rate of return variation of the bond portfolio. Therefore, they are the optimal (i.e., variance-minimizing) hedge ratios, and the R-square of the regression measures the fraction of total bond return variability spanned by the hedging instruments; i.e., it measures the (proportional) variance reduction offered by the optimal hedge.

Bond yields reported by *Moody's Bond Record* on industrial bonds of various rating classes are used to compute bond prices. We assume that in each month an investor purchases a twenty-year maturity par bond with coupon equal to the yield to maturity for that bond rating. The price of the bond at the end of the month is then determined by the yield to maturity reported for the following month. The coupon income plus capital gain or loss is expressed as a percentage of beginning-of-month price (which is always par value because we assume the coupon equals the initial yield to maturity).

The percentage changes of Treasury bond and S&P 500 futures prices are calculated using the nearest-term contract outstanding at the beginning of the month. The regressions cover the twelve-year period July 1982 through June 1994, which provides 144 observations. This period starts shortly after the introduction of stock index futures.

Exhibit 1 shows the results of the hedging analysis for each rating class, assuming that hedge ratios are constant over time. This table thus replicates the analysis of Grieves, although over a sample period roughly four times as long as his.

To illustrate the interpretation of each hedge ratio, take the Baa-rated bond as an example. The coefficients of 0.322 on T-bonds and 0.1017 on the S&P contract indicate that the optimal hedge would call for positions in futures contracts requiring delivery of

EXHIBIT 1 ■ Optimal Fixed Hedge Ratios

				Intercept a_0	T-Bond Futures b_0	S&P 500 Futures c_0
AAA	$\bar{R}^2$	0.6833	coefficient	0.4462**	0.5207**	0.0330
	Durbin-Watson Statistic	2.1849	t-statistic	13.3029	15.7436	1.2748
	Residual Standard Deviation	0.0127	significance	0.0000	0.0000	0.2045
AA	$\bar{R}^2$	0.6218	coefficient	0.5272**	0.4060**	0.0672**
	Durbin-Watson Statistic	2.0482	t-statistic	16.5744	12.9471	2.7355
	Residual Standard Deviation	0.0120	significance	0.0000	0.0000	0.0070
A	$\bar{R}^2$	0.4405	coefficient	0.5764**	0.3288**	0.0958**
	Durbin-Watson Statistic	2.1922	t-statistic	14.3232	8.2860	3.0853
	Residual Standard Deviation	0.0152	significance	0.0000	0.0000	0.0025
BAA	$\bar{R}^2$	0.4616	coefficient	0.5773**	0.3220**	0.1017**
	Durbin-Watson Statistic	1.8956	t-statistic	15.0193	8.4968	3.4298
	Residual Standard Deviation	0.0146	significance	0.0000	0.0000	0.0008

**,*Indicate statistical significance at 1% and 5% levels, respectively.

Exhibit 1 presents results for the regression specification: $R_{bond} = a_0 + b_0 \times$ T-bond $+ c_0 \times$ S&P, where R_{bond} is the bond return for a given rating class in a particular month, and T-bond and S&P denote the percentage changes of the futures prices of the two relevant contracts in that month. Sample period: 1982:7–1994:6.

$0.322 worth of Treasury bonds (at current prices) and $0.1017 of an indexed stock portfolio for every $1 (market value) of bonds held in the portfolio.

At a qualitative level, our results are similar to those of Grieves. Lower-rated bonds have higher hedge ratios on the S&P 500 index, but lower hedge ratios on the Treasury bond contract. As noted, this is consistent with the higher credit risk and lower duration that one would expect of lower-rated bonds. The differences in hedge ratios across rating classes are not nearly as strong as in Grieves's study, however. This difference is due solely to the different sample period. When we restrict our sample period to match Grieves's, our results are identical to his.

To examine the properties of hedge ratios across the business cycle, we need a useful measure of business conditions. A conventional strategy is to partition the sample on the basis of periods of recession and expansion as defined by the NBER. We reject this methodology for two reasons.

First, it often is not clear until several months after the fact that an economy has entered into a recession. Second, economic conditions at the start of a contraction (a peak in the business cycle) are far different from those at the end of a contraction (a trough). Concern over default risk might correspondingly differ, despite the fact the these two dates bracket a common "recession."

We choose instead to use consumer confidence as a measure of economic conditions. We calculate the mean value of the Conference Board's Consumer Confidence Index over the sample period, and define "optimistic periods" as those in which confidence was above its mean value, and "pessimistic periods" as those in which confidence was below its mean. As opposed to a business cycle indicator, this measure has the advantage of being forward-looking and based directly on economic expectations at the time.

Exhibit 2 presents the results for the regression specification:

$$R_{bond} = a_0 + b_0 \times \text{T-bond} + c_0 \times \text{S\&P} + [a_1 + b_1 \times \text{T-bond} + c_1 \times \text{S\&P}] \times \text{(Optimism Dummy)}$$

where R_{bond} is the bond return for a given rating class in a particular month, T-bond and S&P denote the "returns" on the two futures contracts in that month, (more precisely, the percentage change in futures price),

EXHIBIT 2 ■ Optimal Hedge Ratios in Optimistic versus Pessimistic Periods

				Intercept		T-Bond Futures			S&P 500 Futures		
				a_0	a_1	b_0	b_1	$b_0 + b_1$	c_0	c_1	$c_0 + c_1$
AAA	$\overline{R}^2$	0.6974	coefficient	0.3404**	0.1731**	0.6437**	−0.1733*	0.4704**	0.0169	−0.0018	0.0151
	Durbin-Watson Statistic	2.2885	t-statistic	6.6368	2.6069	10.4017	−2.3998	12.6386	0.3926	−0.0345	0.4775
	Residual Standard Deviation	0.0124	significance	0.0000	0.0091	0.0000	0.0164	0.0000	0.6946	0.9725	0.6331
AA	$\overline{R}^2$	0.6309	coefficient	0.4486**	0.1384*	0.4605**	−0.0829	0.3776**	0.0920*	−0.0569	0.0351
	Durbin-Watson Statistic	2.1273	t-statistic	9.1251	2.1745	7.7654	−1.1981	10.5868	2.2344	−1.1150	1.1655
	Residual Standard Deviation	0.0119	significance	0.0000	0.0297	0.0000	0.2309	0.0000	0.0255	0.2649	0.2449
A	$\overline{R}^2$	0.4600	coefficient	0.4650**	0.1905*	0.4296**	−0.1467	0.2829**	0.1078*	−0.0464	0.0614
	Durbin-Watson Statistic	2.2877	t-statistic	7.5181	2.3791	5.7569	−1.6847	6.3031	2.0811	−0.7223	1.6182
	Residual Standard Deviation	0.0150	significance	0.0001	0.0174	0.0000	0.0920	0.0000	0.0374	0.4701	0.1056
BAA	$\overline{R}^2$	0.4947	coefficient	0.4845**	0.1726*	0.3600**	−0.0649	0.2951**	0.1584**	−0.1113	0.0471
	Durbin-Watson Statistic	2.1053	t-statistic	8.2863	2.2794	5.1042	−0.7881	6.9577	3.2342	−1.8331	1.3124
	Residual Standard Deviation	0.0124	significance	0.0000	0.0226	0.0000	0.4307	0.0000	0.0012	0.0668	0.1894

**, *Indicate statistical significance at 1% and 5% levels, respectively.

Exhibit 2 presents results for the regression specification: $R_{bond} = a_0 + b_0 \times$ T-bond $+ c_0 \times$ S&P $+ [a_1 + b_1 \times$ T-bond $+ c_1 \times$ S&P$] \times$ (Optimism Dummy), where R_{bond} is the bond return for a given rating class in a particular month, T-bond and S&P denote the percentage changes of the futures prices of the two relevant contracts in that month, and "Optimism" is a dummy variable that equals 1 in optimistic periods and 0 otherwise. An "optimistic" period is one in which the consumer confidence index is above its sample-average value. Sample period: 1982:7–1994:6.

and "Optimism" is a dummy variable that equals 1 in optimistic periods and 0 in pessimistic periods. Therefore, the hedge ratios for the T-bond and the S&P contracts in pessimistic periods are b_0 and c_0 respectively, while the corresponding hedge ratios in optimistic periods are $b_0 + b_1$ and $c_0 + c_1$. Exhibit 2 accordingly includes columns that report the values of and t-statistics for $b_0 + b_1$ and $c_0 + c_1$.

The results of this regression are striking. Consider first the hedge coefficients on the S&P 500 futures. The hedge ratios in pessimistic periods (given by c_0) range from 0.0169 for Aaa-rated bonds to 0.1584 for Baa-rated bonds. These hedge ratios vary much more dramatically across rating class than they do for the sample period as a whole (compare to Exhibit 1).

On the other hand, the hedge ratios for the S&P futures in optimistic periods (given by the sum $c_0 + c_1$) are far smaller than in Exhibit 1, are generally statistically insignificant, and barely vary across rating classes. In fact, the hedge ratio is slightly lower for Baa-rated bonds than for A-rated bonds, although the difference is not even close to attaining statistical significance.

These results suggest that the "equity component" of bonds, which is due to default risk, is largely ignored during optimistic periods. Bond returns for the most part do not respond to stock market returns in these periods.

The hedge ratios on the T-bond contract also show differences across optimistic and pessimistic periods. The hedge ratios in pessimistic periods (b_0) are uniformly lower than the corresponding ratios in Exhibit 1, indicating that the effective durations of the bonds are lower in these periods. This may reflect the impact of higher perceived default risk. Similarly, with the exception of Aaa-rated bonds, the hedge ratios in optimistic periods ($b_0 + b_1$) are higher than the corresponding ratios in Exhibit 1.