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## Modeling the yields on noninvestment grade bond indexes Credit risk and macroeconomic factors

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### Abstract

To accurately price credit derivatives, it is necessary to understand the underlying factors that determine credit spreads and the influence that external shocks can have on required yields. We model the factors that influence the yield on the most volatile segment of the corporate bond market, noninvestment grade bonds. A long-run equilibrium is found between the yield on BB- and B-rated bonds and Treasury yields, Moody's default rate, and the leading economic indicator. In the short run, changes in Treasury yields, Moody's default rates, and mutual fund flow continue to affect the movements in noninvestment yields. We also find that the resulting error correction models are useful in forecasting the yields. External shocks have a greater effect on the more volatile B-rated bonds. We find that the Iraq invasion of Kuwait, the Russian and Asian financial crises, and Long-Term Capital Management collapse all have influence on noninvestment grade yields. Evidence is also found suggesting a significant flight to quality for BB- and B-rated bonds during the Russian financial crisis.  
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In this paper, we examine the risk factors that move the yields on the most volatile segment of the bond market, non-investment grade. By determining the risk factors and the magnitude of these risk factors on non-investment grade yields, an equilibrium model can be built to determine the relative pricing of current credit derivative instruments(s), to understand the effect of shocks to the market, and to forecast future changes in the index level(s) or credit derivative price(s). We develop separate models for non-investment yields on BB and B assets.

Pricing credit derivatives accurately requires an understanding of the underlying factors that determine yields and correspondingly credit spreads. Analyzing individual credits focuses on interest rate risk, default risk, and liquidity risk. In addition, for credit derivatives on individual assets, it is necessary to understand the determinants of the firm-specific risk and the credit spreads for that individual issue. There has been a great deal of work done in this area (see Boardman & McGinnally, 1981; Fisher, 1959; Silvers, 1973). However, banks and financial institutions are also concerned with macro movements in the credit markets. The risks created by these movements have important consequences on the pricing of the firm's assets and derivatives and on the currently developing markets for credit derivatives, which can be purchased to minimize these risks.

Understanding the factors that influence yields on corporate bonds is not new. There have been three generations of yield premium and yield spread models. The first generation focused (Altman & Benavenga, 1995; Fons, 1987) on the market yield premium for holding risky debt (the average yield spread between risky debt securities and the risk-free security). This break-even type approach is a long-run analysis that calculates whether there is a net return (yield premium minus default rate) for holding risky bonds over a long period. A second generation of yield spread models developed by Fritson and Janssen (1995). These models focus on the short-run dynamics of the credit spreads and include liquidity risk measures and a broad definition of default risk. A third-generation model was developed by Baumhill, Joutz, and Maxwell (2000). The later model merges this information with the second-generation yield premium models focusing on the augmented the first-generation model by adjusting for default risk in the long run and generates the third-generation model by adding moving yields and spreads. We test for the stability of the model(s) over the extremely volatile 1998 and 1999 period through recursive estimation and forecasting. We find that the models are reasonably stable over time and suggest that they can provide value in understanding high-yield securities. Second, the time series properties of the yields, risk factors, and examine the risk factors and macroeconomic variables that can influence the risk of holding high-yield securities. Third, we review some of the previous literature and examine the risk factors and macroeconomic variables that can influence the risk of holding high-yield securities. Finally, we review some of the previous literature and examine the risk factors and macroeconomic variables that can influence the risk of holding high-yield securities.

The paper is organized into six sections. First, we review some of the previous literature and examine the risk factors and macroeconomic variables that can influence the risk of holding high-yield securities. Second, the time series properties of the yields, risk factors, and examine the risk factors and macroeconomic variables that can influence the risk of holding high-yield securities. Third, we review some of the previous literature and examine the risk factors and macroeconomic variables that can influence the risk of holding high-yield securities.

We attempt to further extend the third-generation model by testing additional macroeconomic variables in the long-run "equilibrium" relation in an effort to better understand the underlying process moving yields and spreads. We test for the stability of the model(s) over the extremely volatile 1998 and 1999 period through recursive estimation and forecasting. We find that the models are reasonably stable over time and suggest that they can provide value in understanding high-yield securities. Second, the time series properties of the yields, risk factors, and examine the risk factors and macroeconomic variables that can influence the risk of holding high-yield securities. Third, we review some of the previous literature and examine the risk factors and macroeconomic variables that can influence the risk of holding high-yield securities.

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## 1. Introduction

Default risk is also found to influence credit yields and spreads. Fritson and Jansson (1995) find Moody's trailing-12-month default rate and an index of lagging economic indicators to have a statistically significant effect on (changes in) yield spreads. An index of leading economic indicators was found to have no statistical significance. Baumhill et al. (2000) also find Moody's trailing-12-month default rate to be significant in the long and short run. The default risk and economic indicator measures found in the previous research is perplexing. It is expected that investors would price bonds based on the future probability of default not on the past. The prior research results suggest that investors place a great deal of emphasis on past information in the current pricing of risky debt. Institutional factors like fund covenants require fund managers to allocate their portfolios according to fixed or maximum percentage of non-investment grade instruments. In this study, we include these measures of default risk, but we incorporate them in different ways and come to a different conclusion.

Bookstaber and Jacob (1986), RamaSwami (1991), and Shane (1994) demonstrate that non-investment grade bonds move with equity indexes. This relationship is consistent with the Black and Scholes (1973) model of firm capital structure—contingent claims analysis (CCA). The bondholders' payoff is the value of the bonds (on the upside) or the value of the firm on the downside. In this framework, the closer the value of the bonds is to the total firm value (high leverage), the more highly correlated changes in bond value and changes in equity value will become. The greater the positive difference in the value of the firm compared to the firm on the downside, the closer the value of the bonds (on the upside) is to the total firm value (high leverage).

Non-investment yields depend on interest rate movements of risk-free assets (Treasuries) and factors similar to those of investment grade assets. However, given the nature of non-investment assets, they are more sensitive to default risk, equity markets, future expectations about the economy, and uncertainty related to them.

2. Brief review of the literature on noninvestment grade yields, risk factors, and macroeconomic determinants

Then, we formulate a short-run error correction model (ECM) of the risk premium analysis. The factors influencing the yield and, correspondingly, the "equilibrium" spread of non-investment factors in macroeconomic determinants of yields and the use of the model in credit derivatives pricing.

the market.

most insurance companies, pension funds, and investment grade mutual funds avoid the most volatile section of the non-investment grade bonds). The single B category is dominated by non-investment grade mutual funds as mutual funds (typically investment grade mutual funds are allowed to hold between 5% and 10% of their portfolio in the non-investment grade market) is dominated by insurance companies, pension funds, and investment grade mutual funds (Chase Securities estimates high-yield mutual funds comprise 22% of the market in 1995 (DeRosa-Farag, 1996). Though statistics are not available, diversification with investment bankster suggests that the BB segment of Chase Securities estimates high-yield mutual funds comprise 22% of the market in 1995 (DeRosa-Farag,

from January 1987 through December 1999. To be included in the CS First Boston indexes, or foreign issues, which are a small fraction of the high-yield market. We use monthly data narrated bonds are typically considered to be non-investment grade, but they are usually small typically considered as separate markets with separate dynamic risk factors. In addition, is an active market for distressed securities and debt-for-equity financing, but they are typically very few bonds in this category and they trade at distressed security levels. There are typical segments of the high-yield market. While there are bonds rated CCC/CC/C, they are two largest segments of the high-yield market. In this study, we use CS First Boston's BB and B bond indexes to track the yield on the

In this study, the data series are presented and the time series properties of the variables are tested. The sample period under investigation is January 1987 to December 1999.

### 3. Examination of the data on yields, risk factors, and macroeconomic indicator(s)

There is a well-documented January effect in bond returns (see Chang & Huang, 1990; Chang & Primegar, 1986, 1988; Cooper & Shulman, 1994; Fama & French, 1993; Maxwell, 1998). The January effect is thought to be a function of year tax-loss selling and "window dressing" by institutional investors.

1997; Morck, Schleifer, & Vishny, 1990).

1994; Hoshi, Kashyap, & Scharfstein, 1991; Jones, Lamont, & Lumsdaine, 1998; Lamont, about the business cycle and changes in monetary policy by the Federal Reserve. (For a discussion of macro determinants and their effect on capital markets, see Gertler & Gilchrist, 1994; Hoshi, Kashyap, & Scharfstein, 1991; Jones, Lamont, & Lumsdaine, 1998; Lamont, 1997; Morck, Schleifer, & Vishny, 1990).

Firms issuing non-investment grade instruments are very sensitive to liquidity in the high-yield market. Firms with non-investment rated debt have limited ability to access the more stable bank financing. Hence, they face greater problems raising capital. Their performance and investment spending depend greatly on cash flow, the ability to leverage, and other balance sheet factors. Hence, they are very susceptible to current and future expectations about the business cycle and changes in monetary policy by the Federal Reserve. (For a discussion of macro determinants and their effect on capital markets, see Gertler & Gilchrist, 1994; Hoshi, Kashyap, & Scharfstein, 1991; Jones, Lamont, & Lumsdaine, 1998; Lamont, 1997; Morck, Schleifer, & Vishny, 1990).

Some mutual funds make up a large segment of the market, the change in mutual fund flow and the liquidity position of the mutual funds could have a significant effect on market yield. Bamhill et al. (2000) and Firdason and Jansson (1995) find fund flow into high-yield mutual funds, as a percentage, to be associated with a narrowing of the yield spread and an increase in the price of non-investment grade securities. Net inflows of funds are thought to affect the short-run pricing of securities, but not the fundamentals.

Warriner (1995) finds that mutual fund investment flow influenced stock and bond returns.

Value of the bonds (low leverage), the more highly correlated changes in bond value and changes in risk free bond values will become.

Fig. 1. Yields on 7-year Treasury, BB, and B bonds.

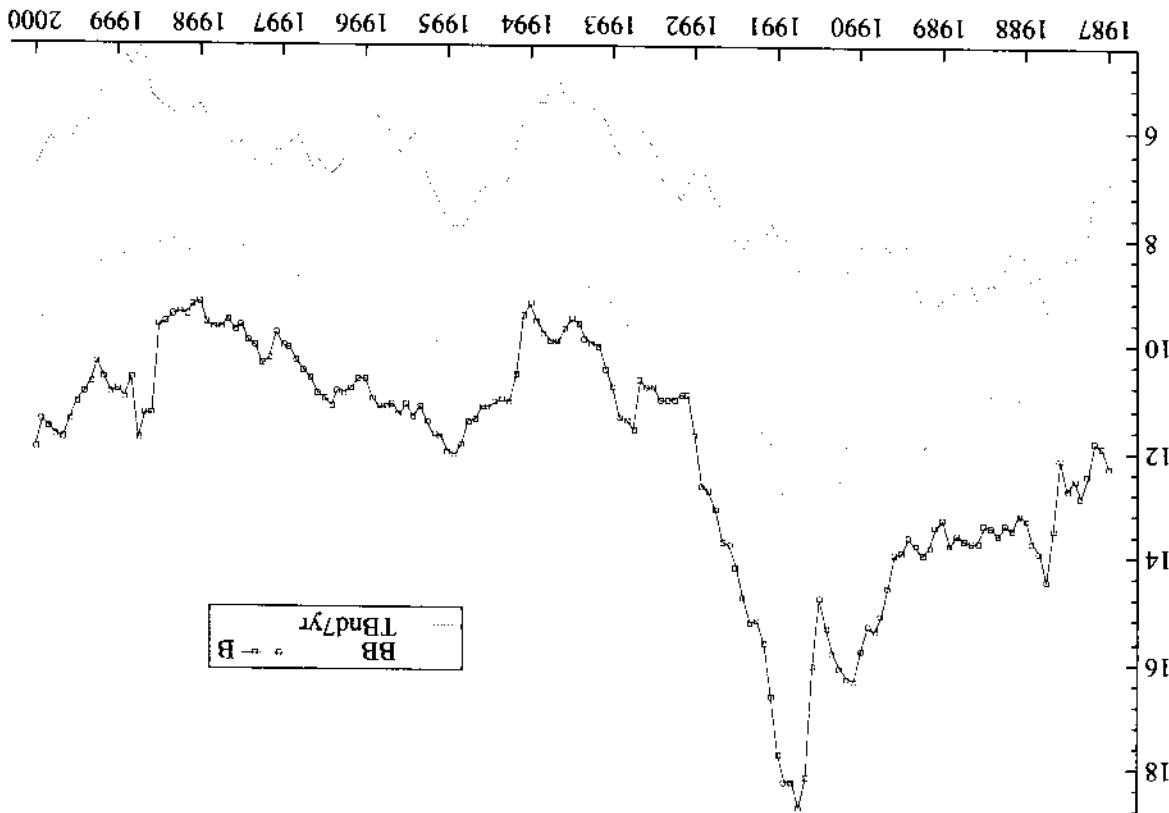


Fig. 2 shows the Moody's 12-month dollar-denominated default rate series and the yield spreads on noninvestment grade bonds. The BB premium has fluctuated between 2% and 4+%. Naturally, the single B's has been more volatile; they have ranged between 4% and 10%. The premiums appear to move closely with the Moody's dollar-denominated default rates.

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Our analysis focuses on five series in particular: BB yields, B yields, the Moody's default rate, 7-year Treasury Bond (T-Bond) yields, and the Conference Board's Leading Economic Indicator. The variables are plotted, the autocorrelation functions are examined, and augmented Dickey-Fuller (ADF) statistics are evaluated for the levels and the first differences of the variables.

Moody's or Standard & Poor's.

The bonds must have at least US\$40 million outstanding and be rated BB or B by either

Fig. 3. Yields on BB, B, and the yield curve. (Spread of 7-year T-Bonds to 3-month T-bills).

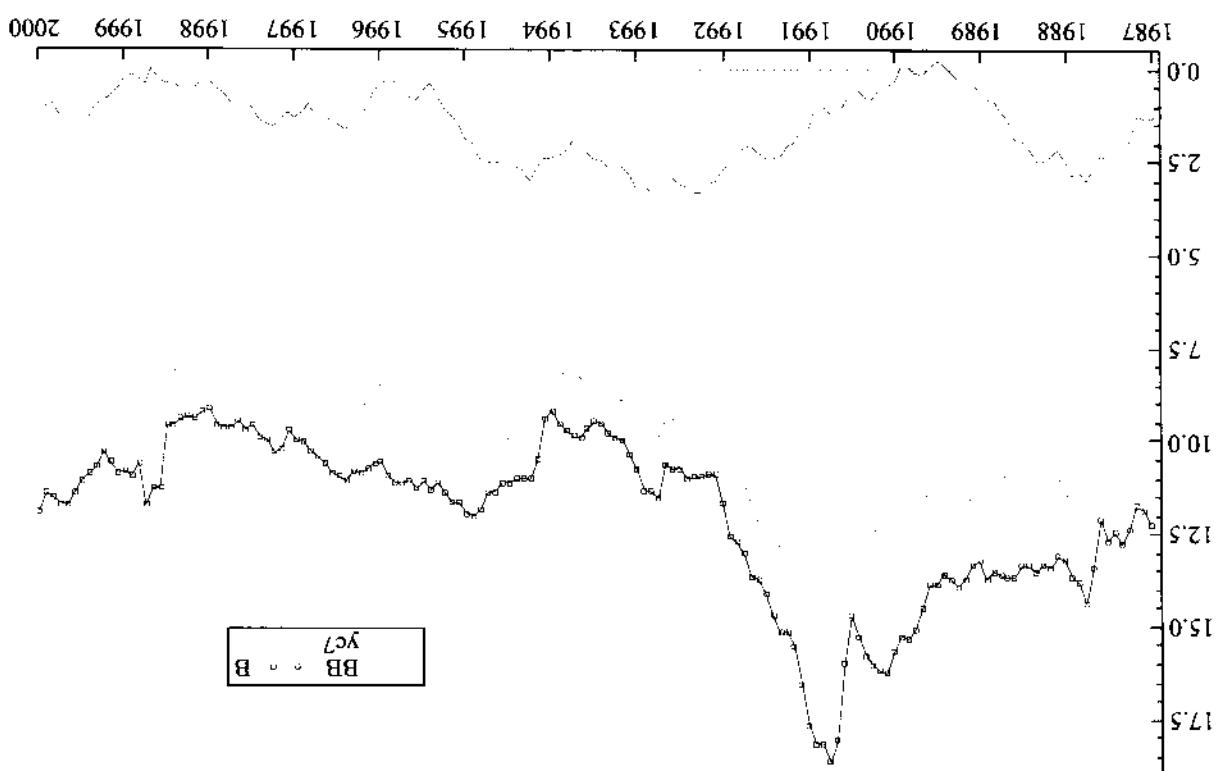


Fig. 2. Moody's default rates and yield spreads for BB and B bonds over T-Bonds.

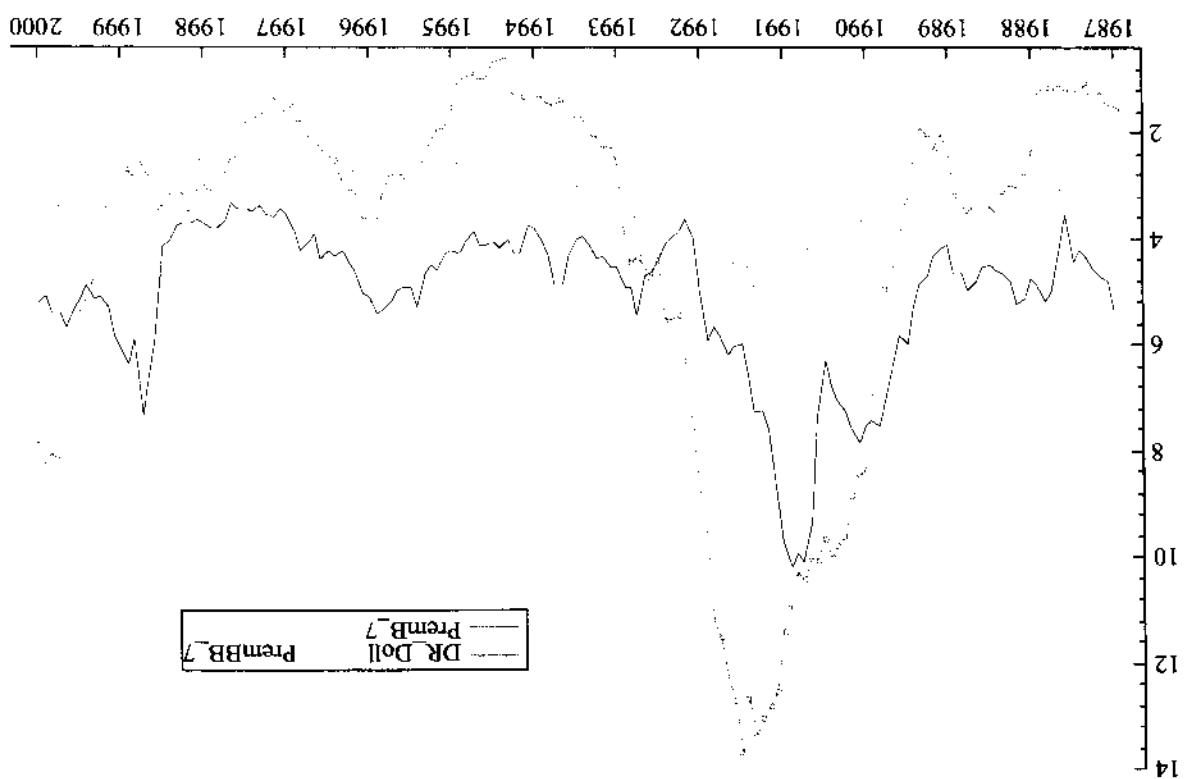


Fig. 5. Yields on B bonds and the leading economic indicator.

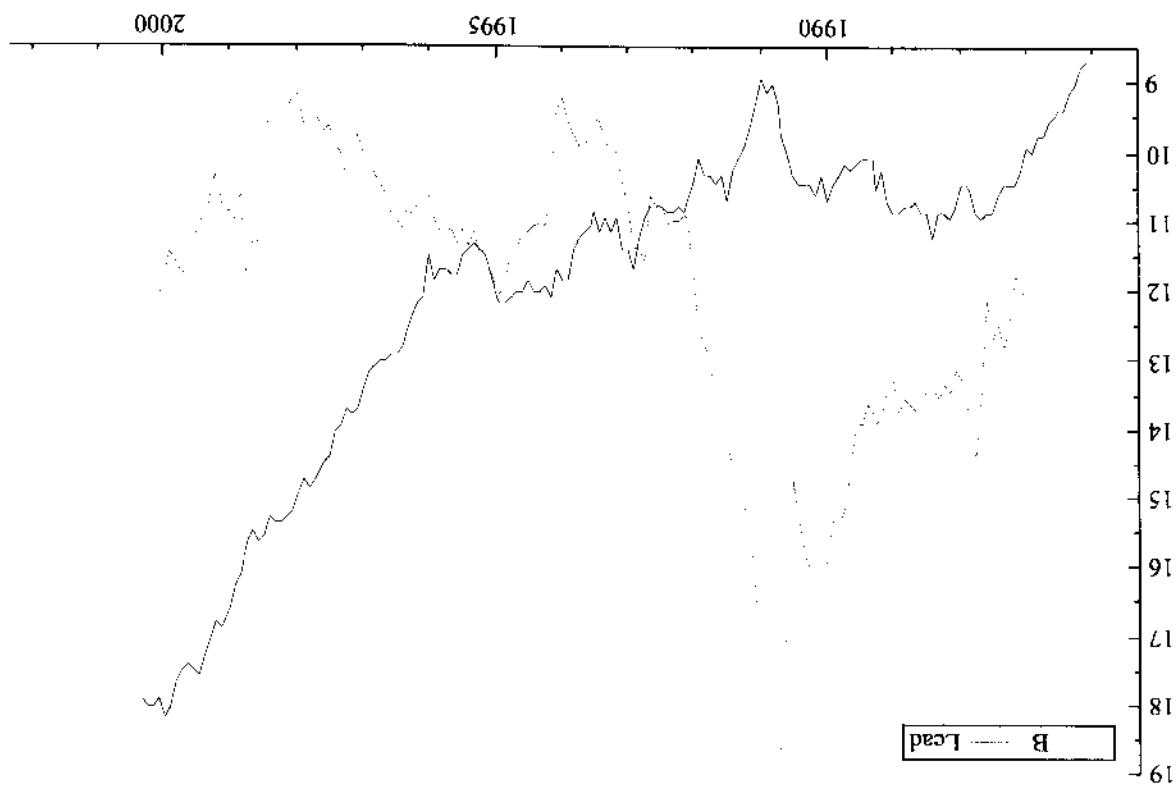


Fig. 4. Yields on BB bonds and the leading economic indicator

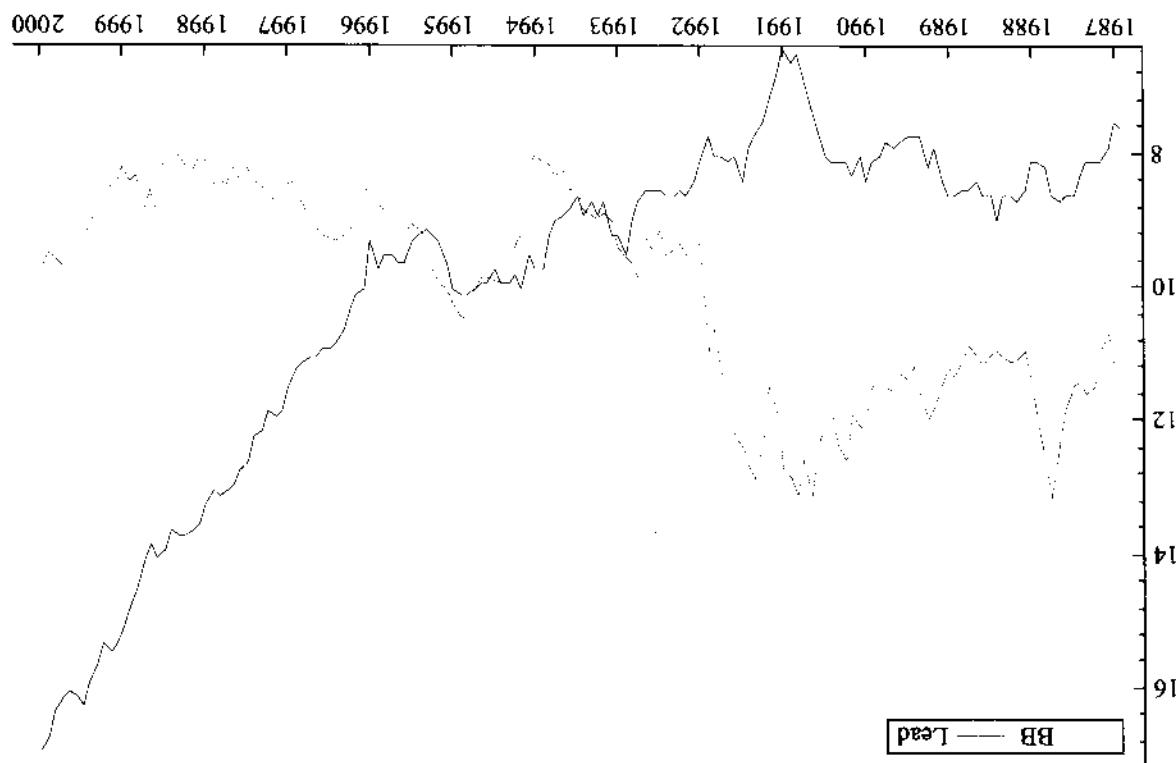
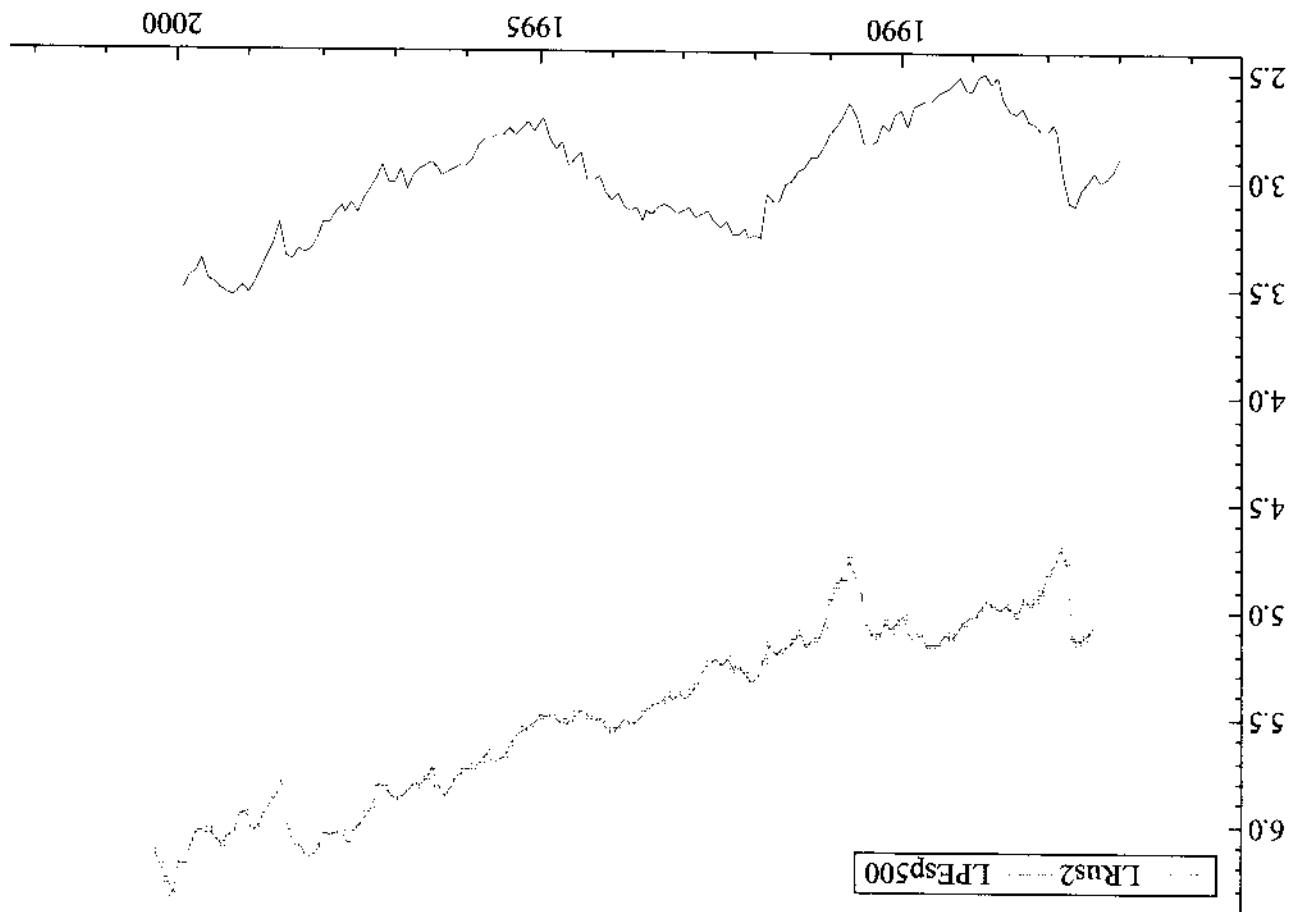


Fig. 6. Equity price measures. Log of the Russell 2000 Index and the S&P 500 price/earnings ratio.



of equities (the log of S&P 500 price/earnings ratio) as independent variables in our analysis. This includes the Russell 2000 Index and a measure of the relative pricing of this into our model, we observe for the high-yield category on a monthly basis. To incorporate previous research has supported the theory by observing correlations between equity prices and investment and nonvaluable for the high-yield category on a monthly basis. To incorporate previous research has supported the theory by observing correlations between equity prices and investment and nonvaluable for the high-yield category on a monthly basis. Previous research has supported the theory by observing correlations between equity prices and investment and nonvaluable for the high-yield category on a monthly basis.

We examine the relationship between noninvestment yield movements and equity markets. The latter seems to capture the importance of future expectations and macroeconomic business cycle impacts on high-yield derivatives. The Conference Board's Leading Economic Indicators series is plotted in Figs. 4 and 5 with the BB and B yields, respectively. We observe the inverse relationship between yields and index over the full sample. Also, when the leading indicator shows or declines, we see that yields increase. When the leading indicator shows or declines, we see that yields increase.

We considered other measures like the yield curve, unemployment indicators, producton index, and the Conference Board's measure of the Leading Economic Indicators. The latter seems to capture the importance of future expectations and macroeconomic business cycle impacts on high-yield derivatives. The Conference Board's Leading Economic Indicators series is plotted in Figs. 4 and 5 with the BB and B yields, respectively. We observe the inverse relationship between yields and index over the full sample. Also, when the leading indicator shows or declines, we see that yields increase.

BB and B returns and the yield curve of 7-year Treasuries to 3-month T-Bills are shown in Fig. 3. It is difficult to infer the relationship here because the yield curve is a function of the two assets and influence of monetary policy. When the curve flattens or inverts, it may suggest an economic slowdown, thus, an increase in the noninvestment yields.

Table 1

Variable	Constant	Constant and trend
BB yields	-1.98 (1)	
B yields	-2.08 (1)	
Moody's default rate	-2.63 (4)	
Yields on 7-year T-Bonds	-1.88 (1)	
Leading Economic Indicator	1.62 (2)	
ADF test for unit root in levels / statistics with lag selection based on AIC for sample July 1987-December 1999	-2.70 (4)	

We have identified a number of external shocks to the market over the period. Dummy variables are included for the month(s) of the following events: the stock market crash (October 1987), the Drexel Burnham bankruptcy (September 1990), and the Iraq invasion of Kuwait (August 1990).

In this paper, we build an equilibrium model of the yield on non-investment grade bonds in magnitude of future shocks.

In this paper, we build an equilibrium model of the yield on the system, we can better understand and project the effect that these shocks have on the system, we can better understand and project the effect for these historical shocks using dummy variables. If we understand the one-time account for these historical shocks the yield on risky debt. In our effort to build a stable model, we time shocks have influenced the yield on risky debt. In our effort to build a stable model, we better understand the effect of external shocks on the markets, and clearly, a number of one-an effort to accurately price market-based credit derivatives. To do this, there is a need to better understand the effect of external shocks on the markets, and clearly, a number of one-

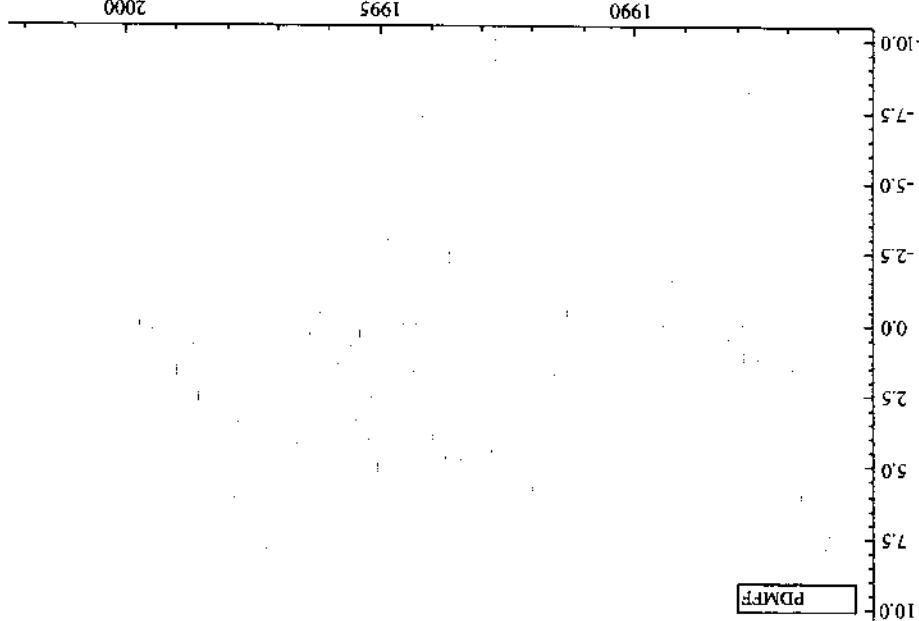
In this paper, we build an equilibrium model of the yield on non-investment grade bonds in

flows move opposite to yields.

This measure is graphed in Fig. 7. Clearly, during times of uncertainty and optimism, the net change in the net inflows in the analysis. ICI provided mutual fund data for the current study. movements, not the equilibrium relationship. We use a measure of the percentage

The series are plotted in Fig. 6. These measures are only used to capture short-run

Fig. 7. Investment Company Institute. Net flows of funds into mutual funds for non-investment grade assets.



Most financial and macroeconomic series are nonstationary. The traditional approach in modeling yields has been to model the data generating process in differences. While this is

The first step in analyzing the data and avoiding a potential spurious regression problem (Granger & Newbold, 1974; Phillips, 1986) is to determine the stationarity or order of integration of the variables. Tables 1 and 2 contain the results from the ADF tests in levels and first differences including specifications with only a constant and a trend, and first differences in levels and five lags and six lags. The specification tests use a maximum of six lags in levels and five lags in differences. The  $t$ -statistic is reported from the model where the lag length is selected by the Akaike information criterion. We cannot reject the null hypothesis of a unit root process for all the series in levels. Except for the default rate series, we clearly can reject the null hypothesis of a unit root for the series in different rates. Further examination of the default rate tests suggests that the difference specification is stationary. The constant and trend models do not reject the null hypothesis that the difference specification is stationary. The constant and trend models do not reject the null hypothesis that the difference specification is stationary. The constant and trend models do not reject the null hypothesis that the difference specification is stationary.

In the summer and fall of 1998, there were several events contributing to the volatility in the high-yield markets. The Russian financial crisis and default precipitated the Asian financial crisis. The derivatives hedging firm Long-Term Capital Management (LTCM) collapsed. The Federal Reserve felt it necessary to respond to these earlier events and the potential impact of the collapses on financial markets. We find that individual dummiest appropriate to capture the impacts of these events and responses (August, September, October, and November 1998). The international financial crises led to "fights to quality" both internationally and domestically in mature markets like the U.S. This increased the spreads on high-yield instruments. The U.S. Federal Reserve encouraged a propelling up and takeover of LTCM and lowered short-run interest rates at FOMC meetings in September and October 1998 to provide liquidity to markets and prevent further defaults.

Table 2  
ADF test for unit root in first differences / statistics with lag selection based on AIC for sample July 1987- December 1999

<sup>2</sup> Test results are available from the authors upon request.

from the *F* tests and associated *P* values for restricting the number of lags for the BB VAR and BB Quinn, and the *F* statistic for model comparison were utilized. Tables 3 and 4 present the results To determine the appropriate lag structure, the log-likelihood, Schwartz criterion, Hannan

considered in the co-integrating vector of the VAR system unrestricted.

and the leading economic indicator. In addition, the other possible explanatory variables not BB or BB. The VARs include the BB and Bond yields, T-Bond yields, Moody's default rates, VAR systems are used; the difference is the noninvestment yield choice in the model, either the Johansen methodology is to determine the appropriate lag structure to use in the VARs. Two co-integration between the noninvestment grade yields and other factors. The first step in the The multivariate methodology developed by Johansen (1988, 1991) is used to test for

results in terms of model stability and identifiability came from the leading indicator series.<sup>2</sup>

like variations of the yield curve, unemployment, and industrial production. However, the best since Board Leading Economic Indicator series. We considered other macroeconomic measures adjusted yield-premium models by incorporating more complex relationship of the default yield spread framework. This examines a slightly more default risk into the traditional conditions. Baumhill et al. (2000) found a model incorporating default risk into the traditional model testing for an equilibrium correction model adjusting for default risk and macroeconomic relationships. We present the co-integration tests for long-run relationships between the simple yield

relationship between the variables.

variables is stationary (see Enders, 1995). Hence, a co-integrating vector indicates a long-run vector is that while the variables may be individually nonstationary a linear combination of interest to determine if there is a co-integrating vector. The implication of a co-integrating differences, as in the second generation of yield spread models, we analyze the variables of equilibrium relationship between variables. So instead of directly moving to a model utilizing common practice, it results in a potential loss of information from the long-run interaction or

\* Statistical significance at 1%.

\* Statistical significance at 5%.

(4 × 4 × no. of lags) and adjusted for the number of degrees of freedom.

grade mutual fund flows. *F* tests and the associated *P* values are reported for the number of restrictions crash d.v., August 1998–December 1999 d.v., log of the S&P 500 price/earnings percent change noninvestment system also includes constant seasonal dummy variables (d.v.), Drexel d.v., Kuwait Invasion d.v., 1987 market differences, as in the second generation of yield spread models, we analyze the variables of equilibrium relationship between variables. So instead of directly moving to a model utilizing rate, yields on 7-year T-Bonds, and the difference in yields between 7-year T-Bonds and 3-month T-Bills. The The BB VAR is a four equation system with the BB yield, Moody's trailing-12-month dollar-denominated default

Lags	1	2	3	4	5	6
1	na					
2	3.19 * * (.00)	na				
3	2.49 * * (.00)	1.73 * (.04)	na			
4	2.38 * * (.00)	1.90 * (.03)	2.01 * (.01)	na		
5	2.05 * * (.00)	1.61 * * (.01)	1.52 * (.04)	1.03 (.42)	na	
6	1.84 * * (.00)	1.46 * (.02)	1.35 (.07)	1.02 (.44)	1.01 (.45)	na

Tests of BB VAR system reduction—lag length selection [*F* test with *P* value (July 1987–December 1999)]

Table 3

Lags	1	2	3	4	5	6
Tests of single B VAR system reduction—lag length selection [ $F$ test with $P$ value (July 1987–December 1999)]						
1	na					
2	3.35 ** [ .00 ]	na				
3	2.77 ** [ .00 ]	2.09 * [ .01 ]	na			
4	2.41 ** [ .00 ]	1.87 * * [ .00 ]	1.61 [ .06 ]	na		
5	2.27 ** [ .00 ]	1.83 * * [ .00 ]	1.65 * [ .02 ]	1.67 * [ .05 ]	na	
6	2.00 ** [ .00 ]	1.6 * * [ .00 ]	1.41 * [ .04 ]	1.30 [ .13 ]	.94 [ .53 ]	na

\*\* Statistical significance at 1%.

\* Statistical significance at 5%.

The single B VAR is a four-equation system with the single B yield, Moody's trailing-12-month dollar-denominated default rate, yields on 7-year-T-Bonds, and the Conference Board's Leading Economic Indicators. The system also includes constant seasonal dummy variables (d.v.), Drexel d.v., Kuwait Invasion d.v., 1987 market crash d.v., August 1998 d.v., October 1998 d.v., November 1998 d.v., log of the S&P 500 price/earnings percent change noninvestment grade mutual fund flows,  $F$  tests are reported for the number of restrictions ( $4 \times 4 \times$  no. of lags) and adjusted for the number of degrees of freedom.

VAR systems, respectively. The main aimed model begins with six lags. We reduce the model down to five lags and test for a loss in explanatory power. The process is repeated down to a single lag. In the BB VAR system, a model with four lags explains, as well as models, with five and six lags. When the B VAR system is reduced to four lags, it does not represent a restriction and six lags. In the BB VAR system, a model with four lags explains, as well as models, with five and six lags. In the BB VAR system, a model with four lags explains, as well as models, with five and six lags. When the B VAR system is reduced to four lags, it does not represent a restriction and six lags. Systems with fewer than four lags do impose significant zero restrictions on the dynamics. The hypothesis of  $r = 0$  is that there is no co-integrating vector. The Lambda or trace statistic that here are no co-integrating vectors is 68.45; the associated  $P$  value is less than 1%. All the trace eigenvalue statistics strongly reject the null hypothesis that there is more than one co-integrating vector. Thus, we conclude that there is a single co-integrating vector in the BB VAR system.

Table 6 contains the results from the B VAR system. Once again, the Lambda or trace statistic of 110.08 is significant at less than 1%. However, the null hypothesis that there is at most one co-integrating vector is rejected; the Lambda or trace statistic is 32.58 and appears to be significant at 2%. There is (marginal) evidence of a second co-integrating vector, but we were unable to identify a second stable co-integrating vector. Fig. 8 presents a plot of recursive estimates for the first and second eigenvalues. The second recursive eigenvalue appears to decline after the first half of the 1990s and is close to zero from 1997 on. The evidence suggests that the B VAR system contains a single long-run or equilibrium relationship.

The results in Tables 5 and 6, along with the correlation analysis above, demonstrate the danger of viewing a constant and instantaneous relationship in yields on very risky debt to the results in Tables 5 and 6, along with the correlation analysis above. The evidence suggests that the B VAR system contains a single long-run or equilibrium relationship.

The results in Tables 5 and 6, along with the correlation analysis above, demonstrate the danger of viewing a constant and instantaneous relationship in yields on very risky debt to the results in Tables 5 and 6, along with the correlation analysis above.

indexes.

<sup>3</sup> Comtegrating vectors between investment grade indexes and Treasury yields were found for all investment grade indexes, which implies the legitimacy of a yield spread model as applied to investment grade indexes.

We next identify the long-run or equilibrium relation in the two VAR systems. In both cases, we interpret them to be modifications of the conventional yield premium model. The yield premium model for noninvestment grade assets is augmented to incorporate default premium factors, and leading procyclical variables. Individually, we expect the value for the T-bond grade yield relationship jointly incorporates the three factors: the T-bond premium, noninvestments and projections about the (macro)economy. Our hypotheses are that the noninvestment grade yields are grade indexes, which implies the legitimacy of a yield spread model as applied to investment grade indexes.

Because they are ex-post measures, Macroeconomic variables like the leading economic indicators, the yield curve, and industrial production can provide information about future equilibrium relationships. Default rates are imperfect measures about the safety of these assets, though it to be fairly constant. The yield on these assets moves 1:1 with T-bond yields. However, changes in the risk-free security.<sup>3</sup> Conventional yield premiums for investment grade bonds are states of the world and the future revenue potential for firms issuing this kind of debt.

\* \*\* Statistical significance at 1%.

The VAR system includes lags of each variable. The system also includes constant seasonal dummy variables S&P 500 price/earnings percents change noninvestment grade mutual fund flows. P values are reported for the weak exogeneity tests.

The VAR system includes four lags of each variable. The system also includes constant seasonal dummy variables (d.v.), Drexel d.v., Kuwait invasion d.v., 1987 market crash d.v., August 1998 - December 1999 d.v., log of the S&P 500 price/earnings percents percent change noninvestment grade mutual fund flows. P values are reported for the weak exogeneity tests.

	BB	Default rate	Treasury yield	Leading indicator
Joint Weak Exog Chisq(3)	0.76	0.99	0.99	0.95
Weak Exog	0.00	0.29	0.1106	0.0579
-0.3852*	0.1173	0.0003	0.0055	0.00567
0.0610	-0.10325*	-0.79028*	-0.16136*	-0.0175

Standardized  $\alpha$  coefficients and standard errors

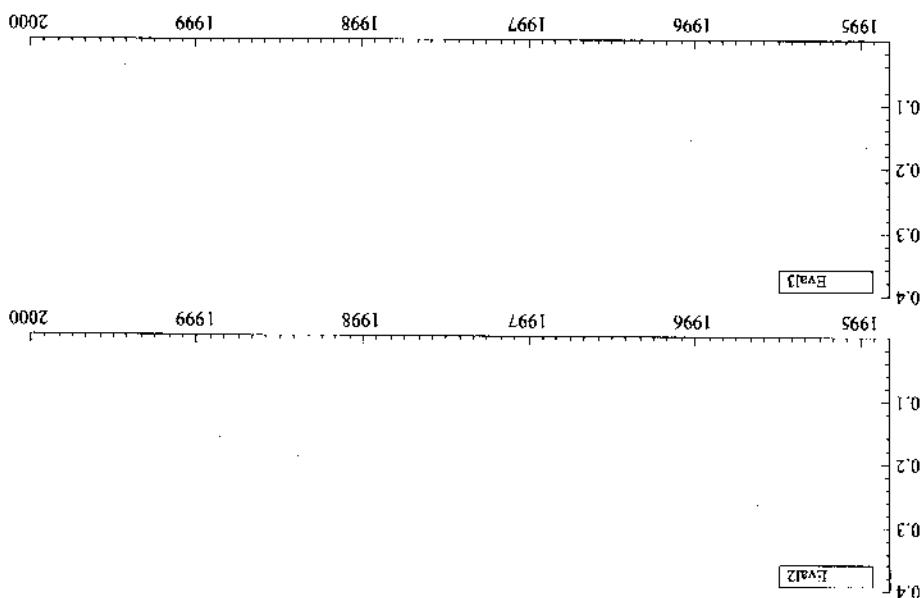
	BB	Default rate	Treasury yield	Leading indicator
1.00	-0.16136*	-0.79028*	-0.10325*	-0.0175
0.07	.00	.68.45	.20.93	.41.9
0.05	.37	.2	.p <= 1	.46.4
0.03	.46	.4	.p <= 3	.46.6

Standardized eigenvalues,  $\beta$  values, and standard errors

Eigenvalue	LogLik for	Rank	H <sub>0</sub> : rank = p	Lambda	P value
0.27	36.2	1	p = 0	68.45	.00
0.07	41.9	2	p <= 1	.20.93	.37
0.05	.46.4	3	p <= 2	.9.58	.32
0.03	.46	4	p <= 3	.56	.46
	12.4	0			

Table 5 Comtegration analysis of BB yields, Moody's trailing-12-month dollar-denominated default rate, yields on 7-year T-bonds, and the Leading Economic Indicator

Fig. 8. Recursive stability test for co-integrating eigenvalue(s) in single B system.



The VAR system includes five lags of each variable. The following variables are centered unless specified: constant seasonal dummy variables (d.v.), Drexel d.v., Kuwait Invasion d.v., 1987 market crash d.v., August 1998 d.v., October 1998 d.v., November 1998 d.v., log of the S&P 500 price/earnings percent change non-investment grade mutual fund flows.  $P$  values are reported for the weak exogeneity tests.

\* Statistical significance at 5%.  
\*\* Statistical significance at 1%.

Eigenvalue	LogLik for	Rank	$H_0: \text{rank } = p$	Lambda	$P$ value
0.401	62.71	1	$p = 0$	110.08	.00* *
0.146	74.60	2	$p < 1$	32.58	.02 *
0.055	78.86	3	$p < 2$	8.81	.39
0.002	79.00	4	$p >= 3$	.29	.59
Standardized eigenvalues, $\beta$ values, and standard errors					
1.00	-0.25076 **	-0.6303 **	0.1223	0.16601 *	0.08136
B	Default rate	Treasury yield	Leading indicator		
	0.26619	0.13753	0.0042	0.0245	
	0.0418	0.0668	0.0359	0.0343	
	0.000 * *	0.04 *	0.89	0.44	
	Joint Weak Exog Chisq(3)		0.20		

$$B_{Index} \text{ Yield} = 0.63T\text{-Bond Yield} + 0.25 \text{ Moody's Default Rate} - 0.17 \text{ Lead} \quad (2)$$

The implied long-run or equilibrium relationship is (Eq. (2)):

Standard errors are reported below the eigenvalues in the table. The LM test for the significance of the three variables is a chi-square(3); the statistic is 32.8, which is significant at 1%. Individually, the signs and magnitudes of the coefficients for the three variable are as expected. The speed of adjustment or alpha coefficient for the BB yield equation is -0.38 and significantly from zero, suggesting that the relationship is stable. The median lag for returning BB yields back to their equilibrium value is slightly more than a month.

-0.16 Lead

BB Index Yield = 0.79T-Bond Yield + 0.103 Moody's Default Rate

Bond coefficient to be positive and less than unity. The relationship between the default rate and to the different yield indexes is as expected. When the bond credit quality decreases, sigmafied by bond rating, the default rate has a greater effect on yield. If leading procyclical variables suggest a positive outlook for the economy, this will have a negative impact on yields as investors expect to earn capital gains on the noninvestment grade assets. Higher yields for firms will enable them to service their debts easier.

This model is fit over the sample August 1987 through December 1999; there are 38 estimated coefficients and 149 observations. The regression  $R^2$  is .66 and the standard error for the change in the yield is 22.8 basis points. There is evidence of an ARCH(1) process, which leads to rejecting normality because of excess kurtosis.<sup>4</sup>

$$\text{where } \text{ECM}_{t-1} = \text{BB}_{t-1} - (-0.10325 \text{ Default}_{t-1} - 0.79028 \text{ T-Bond}_{t-1} + 0.16136 \text{ Lead}_{t-1}) \\ + a_8 \text{ Nov98}_t + a_9 \text{ Dec98}_t + a_{10} \text{ ECM}_{t-1} + e_t \\ + a_2 \text{ Drexel}_t + a_3 \text{ Laird}_t + a_4 \text{ Mar97}_t + a_5 \text{ Aug98}_t + a_6 \text{ Sep98}_t + a_7 \text{ Oct98}_t \\ + \sum_{j=0}^{t-1} \Delta \text{AS&PP}/E_{t-j} \sum_{j=0}^{t-1} \Delta \% \text{ MFFlows}_{t-j} + a_1 \text{ January}_t \\ + \sum_{j=0}^{t-1} \Delta \% \text{ AT-Bond}_{t-j} + \sum_{j=0}^{t-1} \Delta \% \text{ Lead}_{t-j} + \sum_{j=0}^{t-1} \Delta \% \text{ Russ}_{t-j} \\ \text{ABB}_t = a_0 + \sum_{i=1}^3 \Delta \% \text{ ABB}_{t-i} + \sum_{i=0}^3 \Delta \% \text{ AD Default}_{t-i}$$

The BB VAR analysis in Table 3 suggested a four-period lag in levels was the appropriate structure. Hence, we convert this to a model in first differences with a maximum of three lags and include the lagged error correction term from the co-integrating vector (Eq. (1)). The specification of the general ADL is:

5.1. An ECM for BB yields

The results in Section 4 suggest that there is a single co-integrating vector or an "equilibrium relationship except the non-investment grade yield. In this section, we develop the associated conditional single-equation ECM (for further discussion of ECMS, see Enders, 1995; Hendry, 1995). ECMS merge the information from the short-run dynamics of the high-yield indexes with the long-run relationship found in the co-integration analysis. The approach follows the general-to-specific methodology. We begin with an unrestricted autoregressive distributed lag (ADL) model, which includes the estimated "disequilibrium" or error correction mechanism and reduces down to a parsimonious and constant representation.

We test for the three variables, the chi-square(3) has a  $P$  value of .20. We decided to treat the three factors in the modified yield premium relationship for single BB's as weakly exogenous.

## 5. ECMS for non-investment yields: empirical findings

There is no evidence of autocorrelation. However, the problem of an ARCH(1) process remains as does the rejection of normality due to excess kurtosis. The null hypothesis for the heteroskedasticity on the squares of the explanatory variables cannot be rejected with a  $P$  value of .4. The speed of adjustment coefficient from the ECM term,  $-0.1247$ , is negative, significant, and consistent with theory. Thus, the deviation from the "equilibrium" long-run yield is important in helping to explain the short-run dynamics. Treasury rates influence both the long-run and short-run movements. We found that the coefficient on the current and lagged two periods of Treasury yields can be combined and have positive impact on the change in BB yields. (This is effectively the change in the yield over the past quarter.) The previous month's change in the own BB yield,  $-0.193$ , has a negative and significant effect. We interpret this as a form of volatility or overreaction to market information. So there is a partial offsetting of month-to-month changes.

Dynamic default risk measures clearly mitigate the short-run and long-run behavior of BB yields. An increase in the Moody's default measure has effects contemporaneously and with a 1-month lag. The coefficients are equivalent to 9 and 12 basis points, respectively. Conversely, the change in the Russell 2000 index has negative effects in the current month and with a 1-month lag. The coefficient on the Russell 2000 index is  $-0.692$ , respectively. This equity index or market serves as a substitute for investors in high-yield funds.

Table 7 contains the results for the final model. Note the standard error for the change in the yield only increases to 22.9 basis points from 22.8 basis points in going from the unrestricted model to the final model. There are 26 restrictions on the coefficient estimates from the model to the final model. The  $F$  test for the null hypothesis that the final model explains as well as unrestricted ADL model is 1.05 with a  $P$  value of .41. Thus, we cannot reject the null hypothesis that the final ECM has the same explanatory power as the general model.

$$\Delta BB_t = a_0 + \pi_{11} \Delta BB_{t-1} + \sum_{i=0}^{T-1} \pi_{2i} \Delta Default_{t-i} + (\pi_{30} + \pi_{31} + \pi_{32}) \Delta T-Bond_{t-1} \\ + \sum_{j=0}^0 \pi_{5j} \Delta Rus_{t-j} + \sum_{i=0}^{T-1} \pi_{7i} \Delta MFFlows_{t-i} + a_7 Sep98_t + a_8 Oct98_t \\ + a_9 ECM_{t-1} + e_t$$

Since the unrestricted model is overparameterized by definition, we begin the reduction process by examining the explanatory power of different lag lengths and sets of variables from the model always comprising the fit against the unrestricted model and previous reductions. Three decision criteria were used to determine the final specific. First, all variables that were statistically significant at the 95% confidence level were included. Second,  $F$  tests were performed on the alternative models to determine the significance of the loss of information from removing a variable or all variables at a given lag length. For example, the  $S&P$  price/earnings ratio while important in the initial VAR specification did not provide significant explanatory power in the final ECM model. Finally, we conducted residual diagnostic checks and recursive stability analysis for model constancy. The final model includes only 12 estimated coefficients and is given below.

observation until there are  $s = T - 1$  observations. At this point, there are a number of tests for using  $s + 1, s + 2, \dots$ , up to  $T$  observations. The process is repeated by adding one more by estimating the model over first  $s < T$  observations in the same sample and then fit the model estimation techniques. Suppose the original model has  $T$  observations. The technique begins effectively, respectively. Model and parameter consistency can be evaluated using recursive coefficients, respectively. Figs. 9 and 10 show the recursive analysis results for the model and the estimated

in the change of BB yields of slightly more than 75 basis points in October 1998. And the emergence of a takeover/bailout of LTCM. However, our model finds a further increase two cuts in short-term interest rates, implicit promises to provide liquidity to financial markets, spreads on bonds in the mature markets began to return to the previous levels. These included other major central banks to contain the crisis (see International Monetary Fund, 1998), the created flights to quality internationally and domestically. Following efforts by the Fed and BB yields. As is evident by the rise in spreads, the crises and the surrounding uncertainty August, the beginning of the crisis, there was nearly a 100-basis-point increase in the jump of the Russian and Southeast Asian financial crisis and LTCM collapse in the fall of 1998. In Extreme shocks play a small role in the BB ECM model. We found significant effects from instead invest (or diversify) proceeds over a period.

Suggests that mutual funds do not immediately invest the proceeds into the market, but yields. The impact is not only for the current month, but also with a lag. This second effect mutual fund flows have statistically significant and negative effects on changes in BB yields. The Russian and South African financial crisis and LTCM collapse in the fall of 1998. In

\* Statistical significance at 1%.  
\* Statistical significance at 5%.

$$R^2 = .57, \text{Standard error} = .229, \text{Durbin-Watson} = 1.97, \text{AR}(1-4) F(4,127) = .65 [.62] \\ \text{AR}(3,125) = 4.4 [.01], \text{Normality } X^2(2) = 10.8 [.00], \text{Hetero. } X^2(2) F(26,104) = 1.06 [.40]$$

Variable	0 Lag	1 Lag
Long-run solution ECM (Lag 1)	-0.1291 ** (0.042)	
Interest rate risk	0.307 ** (0.042)	
AT-Bonds sum of 0 2 lags	-0.191 * (0.075)	
BB bonds	0.094 * (0.045)	0.122 ** (0.043)
Default rate risk	-0.659 (0.397)	-0.662 (0.379)
ARussell 2000 Stock Index (ln)	0.004 * (0.045)	
AM Moody default rate	0.094 * (0.045)	0.122 ** (0.043)
Liquidity risk	-0.035 ** (0.005)	-0.025 ** (0.005)
Pulse D.V. Aug 98	0.923 ** (0.259)	0.771 ** (0.242)
Pulse D.V. Oct 98	0.771 ** (0.242)	2.58 ** (0.848)
Constant		2.58 ** (0.848)

Final ADL model for noninvestment grade BB yields [estimated coefficients and standard errors (sample August 1987–December 1999)]  
Table 7

consistent with the theory.

Similarly, a graph of the estimated coefficients plus or minus twice the standard error is a revealing plot in that one can examine whether the estimate at some previous time / lies outside the confidence interval at later dates. This is a good test for examining individual coefficients. Fig. 7 presents these tests for each coefficient individually. The recursive coefficients do not appear to significantly trend or jump. Thus, on a model and coefficient basis, we appear to have found a reasonably well-fitting and robust ECM, which is

observation. We conclude that model-wise, the final ECM is stable.

The results are presented graphically normalizing test statistics over the critical values at each observation. If the plot is above unity at an observation, this indicates a rejection of the null hypothesis of no structural break at that point. The Ndn Chow test or Break-Point Chow test is graphed in the bottom half of Fig. 6 and does not suggest a structural break at any

$$\frac{RSS_{t-1}/(T-s+1)}{(RSS_T - RSS_{t-1})(t-k-1)} \approx F(T-s+1, t-k-1) \text{ where } t = s+1, \dots, T$$

Chow test is calculated as:

The textbook approach to model constancy assumes that modeler knows the date of a possible structural break in the sample. They fit the model over the full sample and for the two „halves” of the sample. The full sample implicitly imposes the same model structure throughout and can be considered as a restricted model. This is evaluated against the unrestricted model comprised of the two „halves” using an *F* test. Recursive estimation conducts the Chow tests over the full sample and lets the data do the talking. The Break-Point

The test assumes that the dependent variable,  $y$ , is normally distributed. In our case, this is the change in the BB yields appears to be stationary. This series is plagued by excess kurtosis as mentioned before and suggests that there will be several large outliers. Fig. 6 presents the plot of the one-step Chow tests, and there is only one significant event in late 1991.

$$\frac{RSS_i - RSS_{i-1}(t-k-1)}{RSS_{i-1}} \approx F(1, t-k-1) \text{ where } i = s, s+1, \dots, T$$

There are two types of recursive Chow tests. The first is the one-step Chow test. This looks at the sequence of one-period-ahead predictions from the recursive estimation for period  $t$ . A familiar statistical presentation is the one-step ahead residuals plus the standard error bound used to search for outliers. The one-step residuals are given by  $\hat{e}_t = y_t - x_t \hat{\beta}_t$ , and plotted with the current estimate of  $\pm 2\sigma$ , on either side of zero. When  $\hat{e}_t$  is outside the band, it can be interpreted as an outlier. The tests are  $H(1, j - k - 1)$  under the null hypothesis of parameter constancy. The statistic is calculated as:

evaluating parameter and model constancy. They are often best presented in graphical form, because of the large number of statistics.

Table 8 contains the results for the final model. Note the standard error for the change in the yield increases to 19.2 basis points from 17.9 basis points in going from the final model to the final model in going to the unrestricted ADL model. There are 25 restrictions on the coefficient estimates from the unrestricted ADL model. The  $F$  test for the null hypothesis that the final model explains, as well as the unrestricted ADL model, is 1.55 with a  $P$  value of .69. Thus, we cannot reject the null hypothesis that the final ECM has the same explanatory power as the general model.

$$\begin{aligned} AB_t = & a_0 + \sum_{i=1}^4 AB_{t-i} + \sum_{j=0}^{10} AD_{Default,t-j} + \sum_{j=0}^{30} AT-Bond_t \\ & + \sum_{j=0}^{10} \Delta \% MFFlows_{t-j} + a_1 January_t + a_2 July_t + a_3 Sep90_t + a_6 Mar97_t \\ & + a_7 Aug98_t + a_9 Oct98_t + a_{10} Nov98_t + a_{11} ECM_{t-1} + e_t \end{aligned}$$

This model is fit over the sample October 1987 through December 1999; there are 42 estimated coefficients and 147 observations. The regression  $R^2$  is .87 and the standard error for the change in the yield is 17.9 basis points. The general fit of the model appears better than the BB ECM model. Again, the unrestricted model is overparameterized by definition, so we begin the reduction process by examining the explanatory power of different lag lengths and sets of variables from the model always comparing the fit against the unrestricted model and previous reductions. The final model includes only 13 estimated coefficients and is given below.

where  $ECM_{t-1} = B_{t-1} - (-0.25076 Default_t - 0.6303 T-Bond_{t-1} + 0.16601 Lead_{t-1})$

$$\begin{aligned} AB_t = & a_0 + \sum_{i=1}^4 AB_{t-i} + \sum_{j=0}^{21} AD_{Default,t-j} + \sum_{j=0}^{10} AT-Bond_{t-j} \\ & + \sum_{j=0}^{10} \Delta \% MFFlows_{t-j} + a_1 January_t + a_2 July_t + a_3 Drexel_t + a_4 Ford_t \\ & + a_5 Sep90 + a_6 Mar97_t + a_7 Aug98_t + a_8 Sep98_t + a_9 Oct98_t + a_{10} Nov98_t \\ & + a_{11} Dec98_t + a_{12} ECM_{t-1} + e_t \end{aligned}$$

The B VAR analysis in Table 4 suggested a five-period lag in levels was the appropriate structure. Hence, we convert this to a model in first differences with a maximum of four lags and include the lagged error correction term from the comodification vector (Eq. (1)). The specification of the general ADL is:

specification of the general ADL is:

## 5.2. An ECM for B yields

The  $R^2$  for the model is .83. There does not appear to be any autocorrelation of the residuals; the AR(6) test is 0.90 with a  $P$  value of .49. In addition, we do not observe an ARCH process found in the BB final ECM model. The lack of volatility or (conditional) heteroscedasticity in the model is a bit surprising. The distribution of residuals does not reject the Jarque-Bera normality test with a  $P$  value of .71. We do find that the specification is sensitive to the test for heteroscedasticity in the squared explanatory variables; the  $P$  value is .03.

The spec'd off the adjustment coefficient on the ECM term,  $-0.047$ , is about half that of the BB model. Thus, returns on riskier assets have a faster reversion to their "equilibrium" level. Unlike the BB final ECM, we did not find an effect from previous changes in  $B$  yields. The Moody's default rate measure enters the long-run equilibrium relation and the ECM model. An increase in the current change of the default rate has a positive impact on the  $B$  yield. The Moody's default rate effect is about 18 basis points, but then they fall back by 8 basis points 3 months later.

Unlike the BB final ECM, we did not find an effect from previous changes in  $B$  yields. T-Bonds affect noninvestment grade yields in both the level and changes in the  $B$  yields. T-Bonds have a positive effect of about 58 basis points on the change in yields in yields on T-Bonds do not appear to be persistent. The current change and lags back 4 months, "Excess" returns do not appear to be persistent. The current change and lags back 4 values, "Excess" returns on riskier assets have a faster reversion to their "equilibrium" level. Unlike the BB final ECM, we did not find an effect from previous changes in  $B$  yields. The Moody's default rate measure enters the long-run equilibrium relation and the ECM model. An increase in the current change of the default rate has a positive impact on the  $B$  yield. The Moody's default rate effect is about 18 basis points, but then they fall back by 8 basis points 3 months later.

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\* Statistical significance at 1%.

$$AR(3) F(3,122) = 2.9 [ .83 ], Nomality \chi^2(2) = 8.02 [ .02 ], Heter. X_{12} F(31,96) = 1.65 [ .03 ] \\ R^2 = .83, Standard error = .192, Durbin-Watson = 1.76, AR(1-6) F(6,122) = .90 [ .49 ]$$

Variable	0 Lags	1 Lags	2 Lags	3 Lags
Long-run solution				
ECM (Lag 1)				
Interest rate risk				
AT-Bonds	0.419 * * (0.071)	0.228 * * (0.071)	0.586 * * (0.075)	of lags 1, 3, and 4
ABB bonds sum				
AM Moody's default rate	0.180 * * (0.039)	-0.086 * * (0.037)		
% New mutual fund flows	-0.060 * * (0.005)	0.038 * * (0.006)	-0.027 * * (0.005)	Liquidity risk
January effect	-0.207 * * (0.061)			
Large invasion Aug 90	0.658 * * (0.207)			
Pulse D.V. Sep 90	1.442 * * (0.203)			
Pulse D.V. Mar 97	0.456 * * (0.197)			
Pulse D.V. Aug 98	2.051 * * (0.199)			
Pulse D.V. Oct 98	0.830 * * (0.201)			
Pulse D.V. Nov 98	-1.851 * * (0.230)			
Constant	1.781 * * (0.571)			

Table 8  
Final ADL model for noninvestment grade  $B$  yields [estimated coefficients and standard errors (sample August 1987-December 1999)]

coefficients, respectively. There are only three rejections in the one-step Chow test for the Figs. 11 and 12 show the recursive analysis results for the model and the estimated

investors felt more confident. We find a decline of nearly 180 basis points in that month.

approximatively another 83 basis points. The market began to recover in November as yields—twice the effect of the change in BB yields. In October, yields increased in the fall of 1998. In August, the beginning of the crisis, there was a 200-basis-point increase in found significant effects from the Russian and Asian financial crises and LTCM collapse in Extremeal shocks had a greater impact in the BB ECM model. We

expansion so there was a consensus view that it would be slowing down shortly.

necessary according to Business Week (4/7/97). The economy was in the fifth year of strike on inflationary pressures and there was speculation that only a single increase might be a rising risk of inflation. The increase in short-term rates was interpreted as a preemptive full employment or nonaccelerating inflation rate of unemployment level (NAIRU). Productivity growth was not expected to offset these potential imbalances. The bond market initially did not respond to these statements and hints. Thus, Greenspan and the Fed felt that there was a very strong, and unemployment was at 5.3%; the economy was far above estimates of its Hawkins speech before the Congress on February 26th and March 20th. Aggregate demand Federal Open Market Committee meeting on March 25, the federal funds rate was increased from 5.25% to 5.5%. This was the first increase in 2 years during which rates had been either stable or declining. Chairman Greenspan had hinted at his concerns in the Humphrey-Hawkins speech before the stock market crash in October 1987.

drop experienced in the aftermath of the stock market crash in October 1987. Research Center plunged from 77.3 to 62.9 in August. This decline was twice the size of the 7 years. The index of consumer sentiment produced by the University of Michigan's Survey accordinng to reports in Business Week (9/24/90) during this time. Unemployment had risen from 5.2% in June to 5.6% in August. Private employment growth declined to its lowest pace in as concerns rose about higher oil prices and the negative impacts on economic growth. Oil prices were not the only factor; there already was pessimism about an economic slowdown bonds by 66 basis points in August of 1990, and a further 144 basis points in September of 1990. We find that the Iraqi invasion of Kuwait led to an increase in the required yield on B-rated

the case of negative shocks and/or times of uncertainty.

increasing the spread between Treasuries. This is often referred to as a "flight to quality" in events influencing the underlying yield on Treasury securities and have an additional effect of

The B index is more susceptible to extremeal shocks than the BB final ECM models. These

grade derivatives market (Maxwell, 1998).

There does appear to be a January effect in the final ECM for B yields. The impact is negative and at 5%. This variable is related to mutual fund flows into the noninvestment risky derivatives.

final ECM for B yields. New mutual fund flows put downward pressure on the change in B yields contemporaneously; unlike the BB model where there are lagged effects as well. This may be due to institutional effects, which constrain fund managers from investing in more

The process begins by fitting the model(s) for the period July 1987 through December 1997. Forecasts are generated out 6 months (to June 1988 in the first case). Then, one observation is added and the model(s) are refitted through January 1998. Once again, forecasts are made for 6 months ahead. The process is repeated until November 1999 when only a 1-month-ahead forecast can be made. Thus, we have 24 one-month-ahead forecasts, 23 two-month-ahead forecasts, 22 three-month-ahead forecasts, and 19 six-month-ahead forecasts for evaluation purposes.

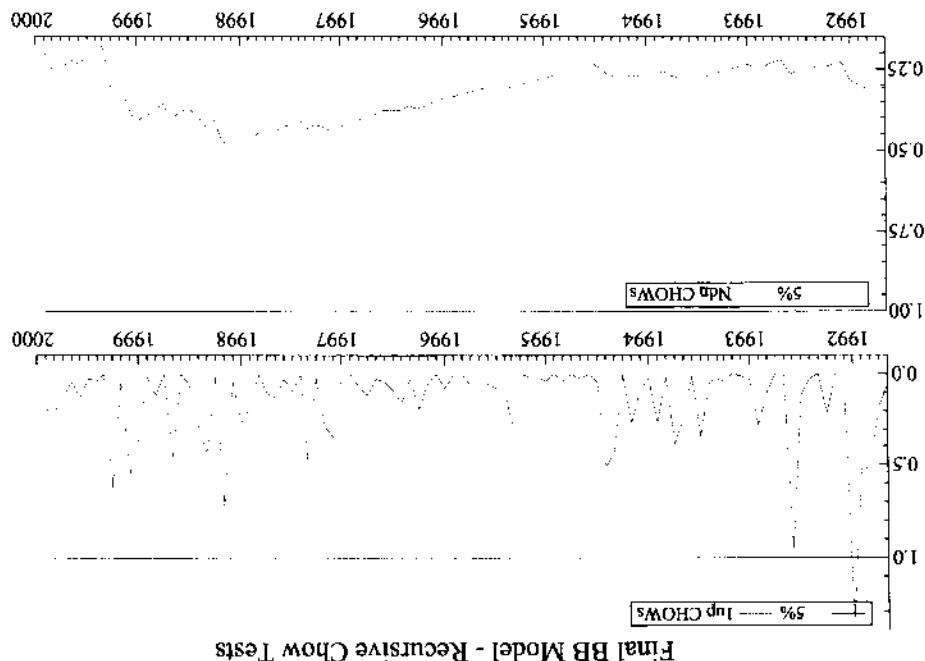
We test the forecast performance of the BB and B models. The forecast evaluation period is from January 1998 through December 1999. There are two kinds of forecasts to compare for the BB and B models. Unconditional dynamic forecasts are made using the actual values for the exogenous variables in one test. In the other test, conditional dynamic forecasts are developed using AR( $p$ ) models to predict the exogenous variables.

Given the test statistics, the stability of the models, and the high  $R^2$ , both models do a good job of modeling the ex-post factors that influence the yield spread. However, for the model to be useful in understanding any pricing trends in the market, it must accurately forecast movements in credit spreads. We examine the ability of the model to forecast yield premiums in credit spreads. We find that the model is able to forecast yield premiums reasonably well in a parsimonious and constant manner.

## 6. Forecast evaluation of models

Spring of 1997 and January 1999. The Break-Point Chow tests are close to rejections at 5% for these observations. Nevertheless, we feel that the final B ECM model reasonably explains the short-run dynamics in a parsimonious and constant manner.

Fig. 9. Final BB Model - Recursive Chow Tests.



All variables have explanatory power for the BB yields. The first row presents the block of reports the block exclusion test for the variables in the BB equation individually and jointly. In Table 9, we report the results from these tests for the BB system. The second column whether they do jointly.

Then, we test if these variables enter each equation in the respective systems and indicators. Then, we test if the default rates, the 7-year T-Bond yields, and the leading economic series in the VAR are significant for both the BB or B yields. The other three tests. We set up a four-variable VAR system for each causality tests or block exogeneity forecasts. This can be tested for by using Granger causality tests or multipeiod ahead forecasts. Strong exogeneity is required to perform conditional dynamic or multipeiod forecasts (Engle, Hendry, & Richard, 1983; Friction, 1992, 1994). Strong exogeneity is not sufficient for forecasting purposes (Engle, Hendry, & Richard, 1983; Friction, 1992, 1994).

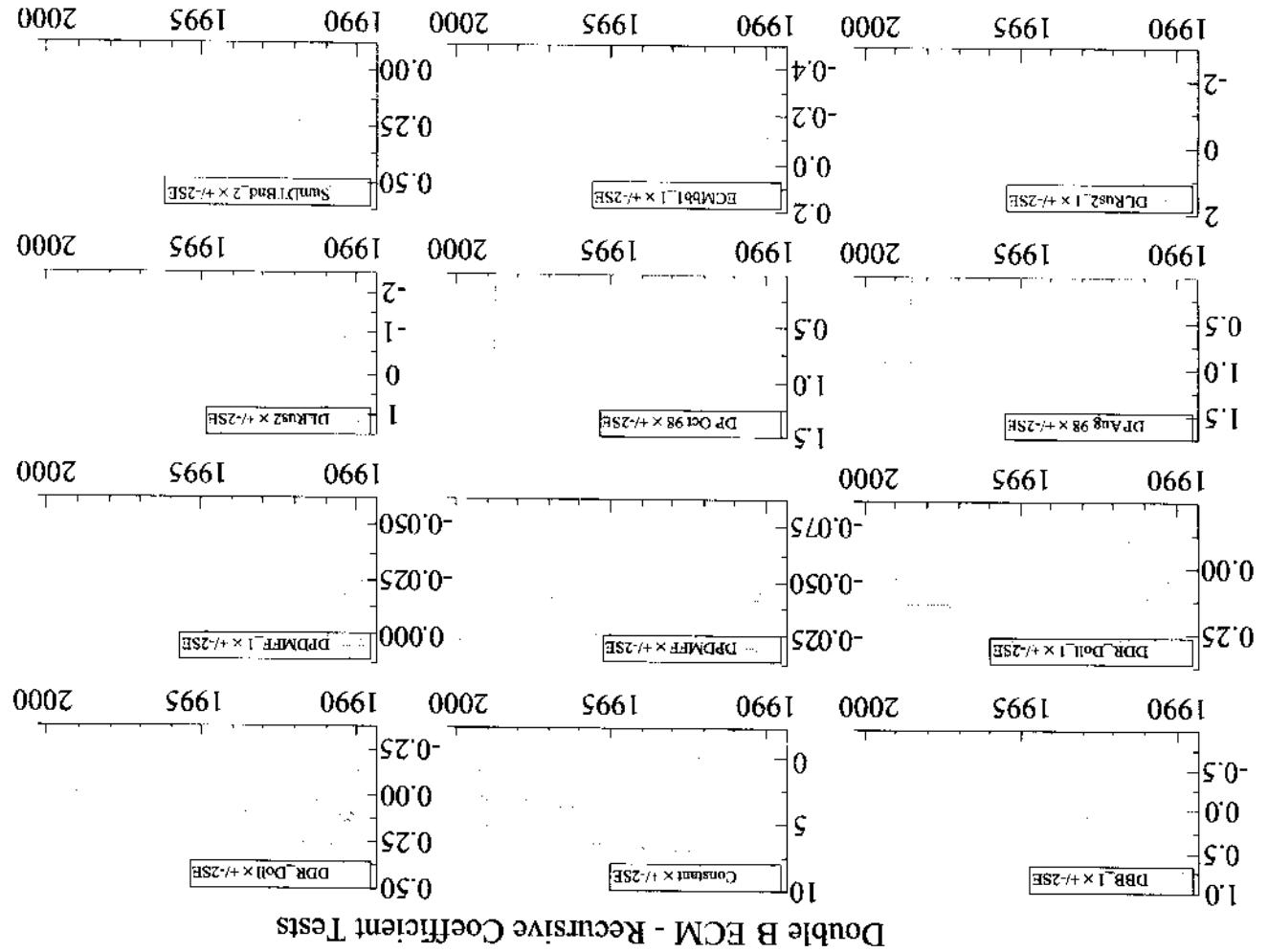
Conventional ECMs were estimated for BB and B yields based on the weak exogeneity tests, which revealed that system estimation was unnecessary. However, the weak exogeneity tests, which revealed that system estimation was unnecessary. However, the weak exogeneity

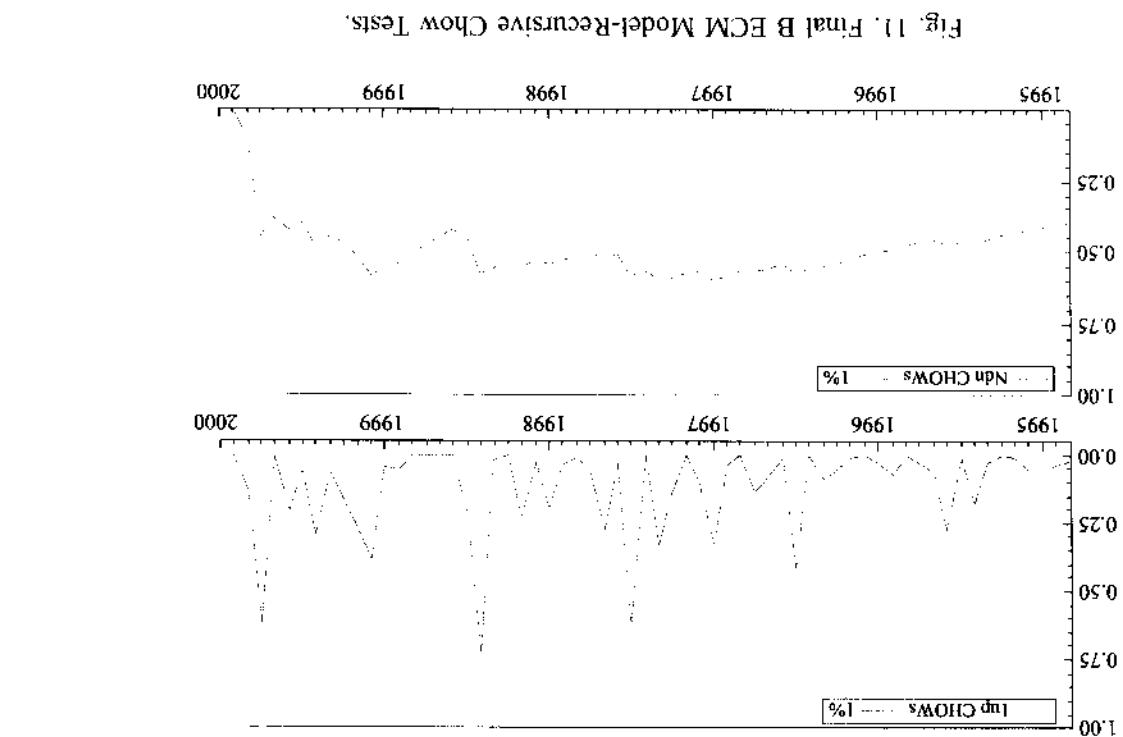
tests, which revealed that system estimation was unnecessary. However, the weak exogeneity tests, which revealed that system estimation was unnecessary. However, the weak exogeneity

stable over time.

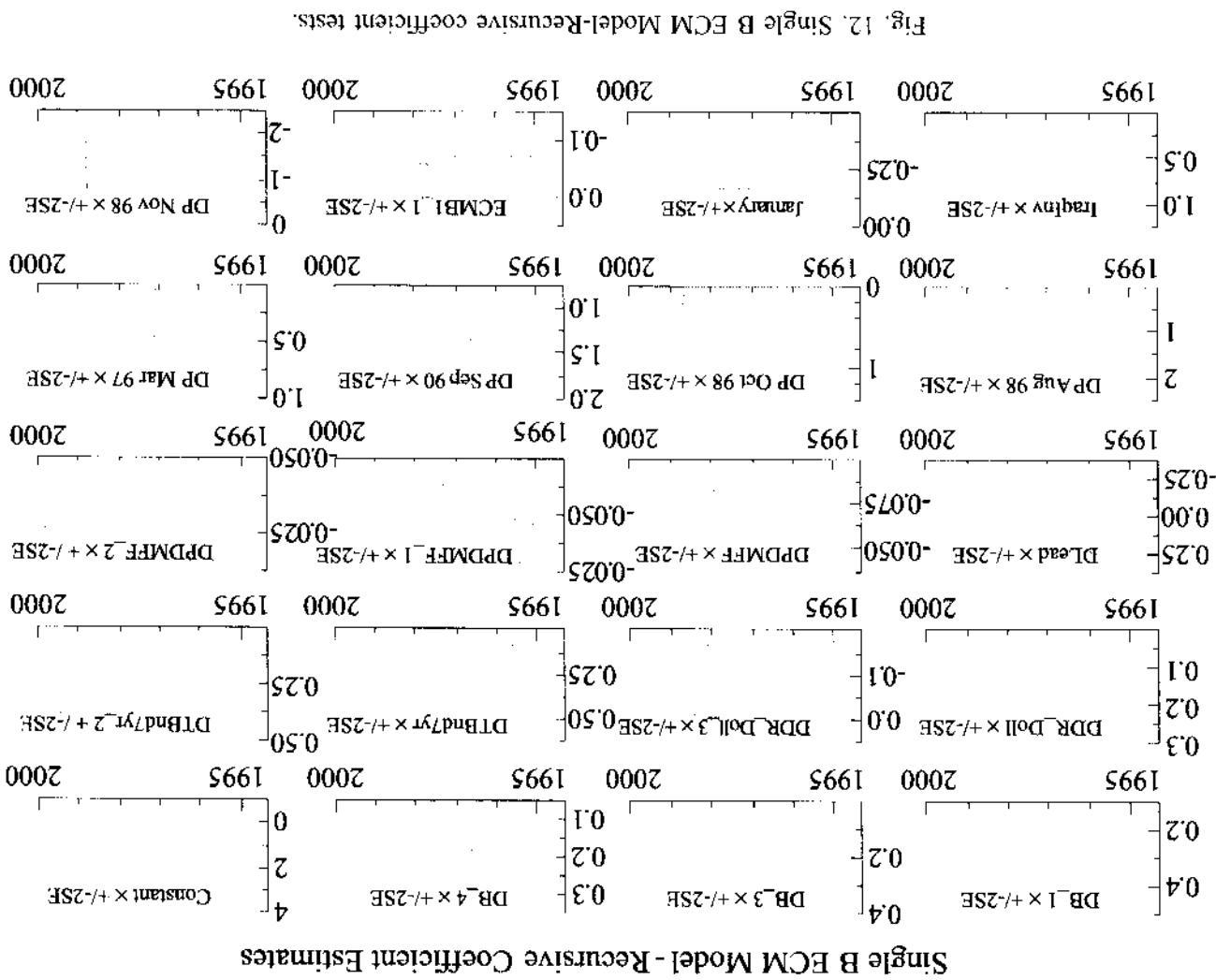
We tested if the cointegrating vector differed using the sample through December 1997 against the December 1999. The null hypothesis that they were the same for BB and B cointegrating relations could not be rejected, and the cointegrating relation is

Fig. 10. Double B ECM-Recurisive coefficient tests.





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	Exclude	Equation	BB	PDMF	TBnd7yr	Lead
BB			7.89 [ .96 ]	8.37 [ .08 ]	3.74 [ .44 ]	5.45 [ .24 ]
PDMF			10.8 [ .03 ]		6.77 [ .15 ]	5.11 [ .28 ]
TBnd7yr			17.04 [ .002 ]		2.46 [ .65 ]	14.55 [ .006 ]
Lead			8.02 [ .09 ]		48.14 [ .00 ]	20.89 [ .05 ]
All variables						28.21 [ .01 ]
						23.87 [ .02 ]

The VAR system is in first differences with four lags of each variable and the sample is from July 1987 to December 1999.

Table 9

VAR pairwise Granger causality or block exogeneity Wald tests [super exogeneity tests for conditional forecasting of BB yields (chi-square with 4 degrees of freedom and P values)]

	Exclude	Equation	BB	PDMF	TBnd7yr	Lead
BB			4.70 [ .32 ]	6.44 [ .17 ]	3.11 [ .54 ]	9.28 [ .06 ]
PDMF			2.97 [ .56 ]		4.40 [ .35 ]	13.44 [ .01 ]
TBnd7yr			5.08 [ .28 ]		3.99 [ .41 ]	6.90 [ .14 ]
Lead					13.97 [ .30 ]	17.36 [ .14 ]
All variables						22.53 [ .03 ]
						27.80 [ .01 ]

The VAR system is in first differences with four lags of each variable and the sample is from July 1987 to December 1999.

Table 10

VAR pairwise Granger causality or block exogeneity Wald tests [super exogeneity tests for conditional forecasting of BB yields (chi-square with 4 degrees of freedom and P values)]

Based on the strong exogeneity results, we decided to model the default rates, the 7-year T-Bond yields, the leading economic indicators, the net mutual fund flows, and Russell 2000 bond yields, the 12-month average and is thus backward, looking.

Table 10 reports similar test for the BB yield system. Here, the evidence is mixed. It appears as though none of the variables helps to explain BB yields. This is troubling, but it may be due to the omission of the comitetrating relation and the general difficulty in modeling this specialized and illiquid market. Surprisingly, BB yields appear to Granger cause the leading economic indicator series; the P value is .06. This seems to be a statistical anomaly and cannot be supported by financial or macroeconomic theory. The results suggest that we can treat the variables as strong exogenous with respect to the noninvestment noninvestment yields. Initially, we had anticipated that default rates might not be strongly exogenous with yields. Bond yields, the leading economic indicators, the net mutual fund flows, and Russell 2000 bond yields, the 12-month average and is thus backward, looking.

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Table 11

Table 11 contains the results of the forecast error evaluation. Forecast errors are defined as the actual yield minus the predicted yield. The BB yield forecasts are presented in the top two parts of the table, and the BYield forecasts are presented in the bottom two parts of the table. The 1-month-ahead, 2-month-ahead, 3-month-ahead, and 6-month-ahead statistics are presented in the second through fifth column, respectively. The mean forecast error, mean absolute error (MAE), the root mean square error (RMSE), and the maximum and minimum forecast error are calculated.

Double B yield forecast error evaluation						
Unconditional forecasts						
	1 Month ahead	2 Months ahead	3 Months ahead	6 Months ahead		
Mean	0.105	0.180	0.247	0.390	0.473	RMSD
MAPE	0.251	0.341	0.351	0.333	0.346	RMSD
RMSE	0.390	0.473	0.507	0.597	0.602	Maximum
MAPE	0.390	0.473	0.507	0.597	0.602	Minimum
RMSE	0.473	0.507	0.597	0.602	0.616	Maximum
MAPE	0.473	0.507	0.597	0.602	0.616	Minimum
RMSE	0.597	0.602	0.616	0.633	0.663	Maximum
MAPE	0.597	0.602	0.616	0.633	0.663	Minimum
RMSE	0.633	0.663	0.694	0.725	0.756	Maximum
MAPE	0.633	0.663	0.694	0.725	0.756	Minimum
RMSE	0.725	0.756	0.794	0.874	0.957	Maximum
MAPE	0.725	0.756	0.794	0.874	0.957	Minimum
RMSE	0.874	0.957	1.058	1.279	2.079	Maximum
MAPE	0.874	0.957	1.058	1.279	2.079	Minimum
RMSE	1.279	2.079	2.471	2.79	3.279	Maximum
MAPE	1.279	2.079	2.471	2.79	3.279	Minimum
RMSE	2.79	3.279	4.058	5.058	6.058	Maximum
MAPE	2.79	3.279	4.058	5.058	6.058	Minimum
RMSE	5.058	6.058	7.518	9.518	11.518	Maximum
MAPE	5.058	6.058	7.518	9.518	11.518	Minimum
RMSE	7.518	9.518	11.518	13.63	16.63	Maximum
MAPE	7.518	9.518	11.518	13.63	16.63	Minimum
RMSE	13.63	16.63	19.64	22.64	25.64	Maximum
MAPE	13.63	16.63	19.64	22.64	25.64	Minimum
RMSE	19.64	22.64	25.64	28.64	31.64	Maximum
MAPE	19.64	22.64	25.64	28.64	31.64	Minimum
RMSE	28.64	31.64	34.64	37.64	40.64	Maximum
MAPE	28.64	31.64	34.64	37.64	40.64	Minimum
RMSE	34.64	37.64	40.64	43.64	46.64	Maximum
MAPE	34.64	37.64	40.64	43.64	46.64	Minimum
RMSE	40.64	43.64	46.64	49.64	52.64	Maximum
MAPE	40.64	43.64	46.64	49.64	52.64	Minimum
RMSE	46.64	49.64	52.64	55.64	58.64	Maximum
MAPE	46.64	49.64	52.64	55.64	58.64	Minimum
RMSE	52.64	55.64	58.64	61.64	64.64	Maximum
MAPE	52.64	55.64	58.64	61.64	64.64	Minimum
RMSE	58.64	61.64	64.64	67.64	70.64	Maximum
MAPE	58.64	61.64	64.64	67.64	70.64	Minimum
RMSE	64.64	67.64	70.64	73.64	76.64	Maximum
MAPE	64.64	67.64	70.64	73.64	76.64	Minimum
RMSE	70.64	73.64	76.64	79.64	82.64	Maximum
MAPE	70.64	73.64	76.64	79.64	82.64	Minimum
RMSE	76.64	79.64	82.64	85.64	88.64	Maximum
MAPE	76.64	79.64	82.64	85.64	88.64	Minimum
RMSE	82.64	85.64	88.64	91.64	94.64	Maximum
MAPE	82.64	85.64	88.64	91.64	94.64	Minimum
RMSE	91.64	94.64	97.64	100.64	103.64	Maximum
MAPE	91.64	94.64	97.64	100.64	103.64	Minimum
RMSE	100.64	103.64	106.64	109.64	112.64	Maximum
MAPE	100.64	103.64	106.64	109.64	112.64	Minimum
RMSE	106.64	109.64	112.64	115.64	118.64	Maximum
MAPE	106.64	109.64	112.64	115.64	118.64	Minimum
RMSE	112.64	115.64	118.64	121.64	124.64	Maximum
MAPE	112.64	115.64	118.64	121.64	124.64	Minimum
RMSE	118.64	121.64	124.64	127.64	130.64	Maximum
MAPE	118.64	121.64	124.64	127.64	130.64	Minimum
RMSE	124.64	127.64	130.64	133.64	136.64	Maximum
MAPE	124.64	127.64	130.64	133.64	136.64	Minimum
RMSE	130.64	133.64	136.64	139.64	142.64	Maximum
MAPE	130.64	133.64	136.64	139.64	142.64	Minimum
RMSE	136.64	139.64	142.64	145.64	148.64	Maximum
MAPE	136.64	139.64	142.64	145.64	148.64	Minimum
RMSE	142.64	145.64	148.64	151.64	154.64	Maximum
MAPE	142.64	145.64	148.64	151.64	154.64	Minimum
RMSE	148.64	151.64	154.64	157.64	160.64	Maximum
MAPE	148.64	151.64	154.64	157.64	160.64	Minimum
RMSE	154.64	157.64	160.64	163.64	166.64	Maximum
MAPE	154.64	157.64	160.64	163.64	166.64	Minimum
RMSE	160.64	163.64	166.64	169.64	172.64	Maximum
MAPE	160.64	163.64	166.64	169.64	172.64	Minimum
RMSE	166.64	169.64	172.64	175.64	178.64	Maximum
MAPE	166.64	169.64	172.64	175.64	178.64	Minimum
RMSE	172.64	175.64	178.64	181.64	184.64	Maximum
MAPE	172.64	175.64	178.64	181.64	184.64	Minimum
RMSE	178.64	181.64	184.64	187.64	190.64	Maximum
MAPE	178.64	181.64	184.64	187.64	190.64	Minimum
RMSE	184.64	187.64	190.64	193.64	196.64	Maximum
MAPE	184.64	187.64	190.64	193.64	196.64	Minimum
RMSE	190.64	193.64	196.64	199.64	202.64	Maximum
MAPE	190.64	193.64	196.64	199.64	202.64	Minimum
RMSE	196.64	199.64	202.64	205.64	208.64	Maximum
MAPE	196.64	199.64	202.64	205.64	208.64	Minimum
RMSE	202.64	205.64	208.64	211.64	214.64	Maximum
MAPE	202.64	205.64	208.64	211.64	214.64	Minimum
RMSE	208.64	211.64	214.64	217.64	220.64	Maximum
MAPE	208.64	211.64	214.64	217.64	220.64	Minimum
RMSE	214.64	217.64	220.64	223.64	226.64	Maximum
MAPE	214.64	217.64	220.64	223.64	226.64	Minimum
RMSE	220.64	223.64	226.64	229.64	232.64	Maximum
MAPE	220.64	223.64	226.64	229.64	232.64	Minimum
RMSE	226.64	229.64	232.64	235.64	238.64	Maximum
MAPE	226.64	229.64	232.64	235.64	238.64	Minimum
RMSE	232.64	235.64	238.64	241.64	244.64	Maximum
MAPE	232.64	235.64	238.64	241.64	244.64	Minimum
RMSE	238.64	241.64	244.64	247.64	250.64	Maximum
MAPE	238.64	241.64	244.64	247.64	250.64	Minimum
RMSE	244.64	247.64	250.64	253.64	256.64	Maximum
MAPE	244.64	247.64	250.64	253.64	256.64	Minimum
RMSE	250.64	253.64	256.64	259.64	262.64	Maximum
MAPE	250.64	253.64	256.64	259.64	262.64	Minimum
RMSE	256.64	259.64	262.64	265.64	268.64	Maximum
MAPE	256.64	259.64	262.64	265.64	268.64	Minimum
RMSE	262.64	265.64	268.64	271.64	274.64	Maximum
MAPE	262.64	265.64	268.64	271.64	274.64	Minimum
RMSE	268.64	271.64	274.64	277.64	280.64	Maximum
MAPE	268.64	271.64	274.64	277.64	280.64	Minimum
RMSE	274.64	277.64	280.64	283.64	286.64	Maximum
MAPE	274.64	277.64	280.64	283.64	286.64	Minimum
RMSE	280.64	283.64	286.64	289.64	292.64	Maximum
MAPE	280.64	283.64	286.64	289.64	292.64	Minimum
RMSE	286.64	289.64	292.64	295.64	298.64	Maximum
MAPE	286.64	289.64	292.64	295.64	298.64	Minimum
RMSE	292.64	295.64	298.64	301.64	304.64	Maximum
MAPE	292.64	295.64	298.64	301.64	304.64	Minimum
RMSE	298.64	301.64	304.64	307.64	310.64	Maximum
MAPE	298.64	301.64	304.64	307.64	310.64	Minimum
RMSE	304.64	307.64	310.64	313.64	316.64	Maximum
MAPE	304.64	307.64	310.64	313.64	316.64	Minimum
RMSE	310.64	313.64	316.64	319.64	322.64	Maximum
MAPE	310.64	313.64	316.64	319.64	322.64	Minimum
RMSE	316.64	319.64	322.64	325.64	328.64	Maximum
MAPE	316.64	319.64	322.64	325.64	328.64	Minimum
RMSE	322.64	325.64	328.64	331.64	334.64	Maximum
MAPE	322.64	325.64	328.64	331.64	334.64	Minimum
RMSE	328.64	331.64	334.64	337.64	340.64	Maximum
MAPE	328.64	331.64	334.64	337.64	340.64	Minimum
RMSE	334.64	337.64	340.64	343.64	346.64	Maximum
MAPE	334.64	337.64	340.64	343.64	346.64	Minimum
RMSE	340.64	343.64	346.64	349.64	352.64	Maximum
MAPE	340.64	343.64	346.64	349.64	352.64	Minimum
RMSE	346.64	349.64	352.64	355.64	358.64	Maximum
MAPE	346.64	349.64	352.64	355.64	358.64	Minimum
RMSE	352.64	355.64	358.64	361.64	364.64	Maximum
MAPE	352.64	355.64	358.64	361.64	364.64	Minimum
RMSE	358.64	361.64	364.64	367.64	370.64	Maximum
MAPE	358.64	361.64	364.64	367.64	370.64	Minimum
RMSE	364.64	367.64	370.64	373.64	376.64	Maximum
MAPE	364.64	367.64	370.64	373.64	376.64	Minimum
RMSE	370.64	373.64	376.64	379.64	382.64	Maximum
MAPE	370.64	373.64	376.64	379.64	382.64	Minimum
RMSE	376.64	379.64	382.64	385.64	388.64	Maximum
MAPE	376.64	379.64	382.64	385.64	388.64	Minimum
RMSE	382.64	385.64	388.64	391.64	394.64	Maximum
MAPE	382.64	385.64	388.64	391.64	394.64	Minimum
RMSE	388.64	391.64	394.64	397.64	400.64	Maximum
MAPE	388.64	391.64	394.64	397.64	400.64	Minimum
RMSE	394.64	397.64	400.64	403.64	406.64	Maximum
MAPE	394.64	397.64	400.64	403.64	406.64	Minimum
RMSE	400.64	403.64	406.64	409.64	412.64	Maximum
MAPE	400.64	403.64	406.64	409.64	412.64	Minimum
RMSE	406.64	409.64	412.64	415.64	418.64	Maximum
MAPE	406.64	409.64	412.64	415.64	418.64	Minimum
RMSE	412.64	415.64	418.64	421.64	424.64	Maximum
MAPE	412.64	415.64	418.64	421.64	424.64	Minimum
RMSE	418.64	421.64	424.64	427.64	430.64	Maximum
MAPE	418.64	421.64	424.64	427.64	430.64	Minimum
RMSE	424.64	427.64	430.64	433.64	436.64	Maximum
MAPE	424.64	427.64	430.64	433.64	436.64	Minimum
RMSE	430.64	433.64	436.64	439.64	442.64	Maximum
MAPE	430.64	433.64	436.64	439.64	442.64	Minimum
RMSE	436.64	439.64	442.64	445.64	448.64	Maximum
MAPE	436.64	439.64	442.64	445.64	448.64	Minimum
RMSE	442.64	445.64	448.64	451.64	454.64	Maximum
MAPE	442.64	445.64	448.64	451.64	454.64	Minimum
RMSE	448.64	451.64	454.64	457.64	460.64	Maximum
MAPE	448.64	451.64	454.64	457.64	460.64	Minimum
RMSE	454.64	457.64	460.64	463.64	466.64	Maximum
MAPE	454.64	457.64	460.64	463.64	466.64	Minimum
RMSE	460.64	463.64	466.64	469.64		

turbulence in the financial markets. bonds during periods of pessimism and uncertainty in the macroeconomic outlook and strength. We also find evidence that suggests a flight to quality from B- to BB-rated bonds of these factors on the long-run equilibrium and the short-run model differ in degree.

While we find a number of common factors affecting B- and BB-rated bonds, the relative

ous. Finally, there is a danger in viewing the noninvestment grade market as being homogen-

B index.

Finally, the difference in viewing the noninvestment grade market as being homogen-

B index.

Furthermore, the estimated error-correction models are found to be useful in forecasting

the equilibrium relation.

In addition to a long-run equilibrium, short-run dynamics factors also influence monthly

yield spreads. The dynamics of the B and BB indexes are explained by changes in the

Moody's default rate, changes in the Treasury yield, and changes in mutual fund flows. The

strongest explanatory variable in each model is the change in mutual fund flow. Our results

also indicate that the lower credit quality indexes are more sensitive to changes in mutual

fund flow. A weakly significant January effect is found in BB-rated bonds. A number of

extreme events were found to have statistically and economically significant effects on yields.

For both the B and BB index, the Russian and Asian financial crises lead to a significant

increase in the required premium for noninvestment grade bonds. For B-rated bonds, the large

invasion of Kuwait, and the Russian and Asian crises also lead to increased yield spreads over

time. A weakly significant January effect is found in B-rated bonds. For B-rated bonds, the large

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## 7. Summary

Large underpredictions, positive errors, appear much bigger than the overpredictions. Nearly every one of these occurs in August 1998 or from September through November. Nearly every year, the 6-month-ahead conditional forecasts for May 1999 are rather large as well. This must be due to forecasts of the exogenous variables, but it is not clear which of the variables is the culprit. The overpredictions are not clustered in any particular period. Overall, we find that the models do a good job of forecasting yields and should provide a useful tool in pricing credit derivative instruments.

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## Further-reading