Macroeconomic Variables, Pricing Kernels and Expected Default-Free and Defaultable Bond Returns

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Abstract

This paper investigates how macroeconomic variables perform in forecasting of the US Treasury and defaultable bond returns within the linear regression and the *no-arbitrage* GMM frameworks. We model the pricing kernel, the object whose evolution is driven by changes in investors' discount rates and risk attitudes, and *credit return premia* governed by changes in riskiness of future cash-flows of defaultable bonds. We find that the macroeconomic variables help in predicting future bond returns even after controlling for intrinsic term-structure factors summarized by the forward rates. In addition to having rich dynamics, the estimated pricing kernel tends to increase right before or at the very beginning of, and the credit return premia during, the NBER recessions. These results are consistent with the previous findings that default rates and investors' risk-aversion are counter-cyclical, and recovery rates are pro-cyclical.

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1 Introduction

Defaultable debt instruments, such as corporate bonds, are riskier than their government-issued counterparts that have the same maturity, face value, coupon structure and other characteristics. Unless investors are considerably risk-seeking they will demand higher expected returns as a compensation for holding defaultable rather than Treasury bonds. Over time, changes in expected excess returns on defaultable bonds[1] are thus driven by changes in their riskiness and in investors' risk attitudes. Technically speaking , they are governed by changes in expected cash-flows, for instance due to expected default loss, and changes in risk-premia, related to the returns' covariance with the stochastic discount factor. But what economic forces in turn determine the behavior of the returns and their individual components? In this work, we investigate how expected excess returns on defaultable bonds change with the business cycles.

According to Fama and French (1989) and others business conditions affect expected returns of stocks and corporate bonds. One explanation is that investors are more risk-averse and demand higher expected returns in recessions (and vice versa during expansions). Econometrically, examining time variation in expected returns amounts to forecasting future returns with relevant current variables. This logic has also been recently applied by Ludvigson and Ng (2006) and Kim and Moon (2005), who use macroeconomic variables to predict excess returns of Treasury bonds. Indeed, Ludvigson and Ng (2006) find countercyclical behavior in bond risk premia. These are expected excess returns on very liquid securities with certain terminal payoffs and, therefore, their evolution is mostly associated with changes in the market (interest rate) risk premia. However, if factors affecting Treasury and defaultable bond risk premia overlap, then such patterns are expected to extend, at least partially, to excess returns of defaultable bonds.

[1]By *excess return* we mean the premium that returns of defaultable bonds pay in excess of what is offered by default-free bonds with otherwise similar characteristics. By *expected* we mean *conditionally* expected.

Among the factors that influence excess returns on defaultable bonds, are possibilities of default and incomplete value recovery conditional on default (the two constitute the *credit risk*), liquidity effects and differences in tax treatment[2]. In fact, difficulties that extant credit risk pricing models have historically experienced with explaining the observed magnitudes of differences between yields of Treasury and defaultable bonds are often referred to as the *credit spread puzzle*[3].

Yet, it has been demonstrated that the credit spread puzzle becomes significantly less pronounced in structural models where macroeconomic variables influence firms' cash flows[4]. Such theoretic insights from structural models are consistent with the findings from empirical studies on default and recovery rates[5] suggesting that both comove to a certain extent with the business cycles.

Despite the evidence and predictions by the literature that individual components of excess expected returns on defaultable bonds should co-move with the macroeconomic variables, there is little direct empirical work on their relationship to macro conditions[6]. In this article, we explore these links and confirm that macroeconomic variables do contain relevant forecasting information. In addition, we document intuitive patterns in the dynamics of the key components contributing to the evolution of excess returns.

We start by assuming that returns on defaultable bonds are equal to returns on Treasury bonds with similar maturities after adjusting for what we refer to as the *credit return premium*[7]. We run time-series forecasting regressions for the realized one year excess returns

[2] e.g. Driessen (2005).

[3] e.g. discussion in Elton, Gruber, Agrawal and Mann (2001).

[4] e.g. Hackbarth, Miao and Morellec (2006)

[5] e.g. Blume and Keim (1991), Fons and Kimball(1991), Jonsson and Fridson (1996), Duffie and Singleton (2003), Gupton and Stein (2002).

[6] We discuss some of the relevant papers in a subsequent subsection.

[7] Credit return premium reflects both expected cash-flows and any risk premia associated with the factors affecting these cash-flows.

of investment grade bonds on the two sets of predictive variables consisting of Treasury forward rates and macroeconomic variables. The former set of variables has been demonstrated to work well for forecasting excess returns on Treasury bonds by Cochrane and Piazzesi (2005), and it is interesting to examine its predictive ability for the investment-grade bonds. The latter set consists of of real (employment and production-related) and nominal (inflation-related) variables. We utilize returns on bonds of three different maturities: short, intermediate and long. Adjusted R^2s from forecasting regressions vary across maturities and sets of explanatory variables, but reach up to 43%.

We then employ Euler-equation-based GMM estimation procedure to investigate to what extent the macroeconomic variables lead and co-move with excess defaultable returns within the no-arbitrage framework. We model the pricing kernel and the credit return premia as functions[8] of indices of the same two sets of observable variables utilized in regressions: forward rates and macro variables. Each index is a linear combination of its constituents, where the weights of individual components are estimated jointly with the parameters of the pricing kernel and credit return premia functions. We are able to identify the parameters of both functions, because we jointly utilize the data on Treasury and defaultable returns. In particular, the pricing kernel enters both the moment conditions for both types of returns, and the credit return premium enters only the moment conditions for returns on defaultable bonds. In addition, by using both sets of returns we jointly model the interest rate risk and the risks specifically associated with holding the defaultable bonds, such as credit and liquidity risks. Last but not least, in contrast to time-series forecasting regressions, utilizing Euler equations does not only enable us to identify the pricing kernel, and thus risk attitudes and discount rates, separately from the credit return premia, and thus cash-flow riskiness, but also to impose internally consistent no-arbitrage pricing restrictions on returns of bonds of different types and maturities.

[8]The framework allows us to investigate the empirical performance of various functional forms, including non-linear.

We examine whether macroeconomic variables have any marginal predictive and explanatory power of their own as well as together with forward rates. Our tests of over-identifying moment conditions strongly advocate for relevance of macroeconomic variables. In addition, we recover and examine the time series for model-impled pricing kernel and credit return premia, who both can be categorized with quite rich dynamics. At the same time, the estimated pricing kernel tends to increase right before or at the very beginning of, and the credit return premia during, the NBER recessions. These results are consistent with the previous findings that default rates and Treasury bond risk premia increase and recovery rates decrease during recessions.

The rest of the paper is organized as follows. In subsection 1.1, we provide more details on our contribution and how our approach is related to the literature. Next, we discuss modeling issues in section 2 and describe the data in section 3. Section 4 presents forecasting regression methodology and results. In section 5 we describe the GMM methodology and results. We finally conclude in section 6.

1.1 Our Approach and Related Literature

Our forecasting exercise is related to the studies that focus on expected excess returns of long relative to short Treasury bonds and evolution of bond risk-premia. The expectation hypothesis implies that these excess returns are not forecastable. However, an impressive array of empirical studies appears to be at odds with such a conjecture[9].

Returns of defaultable bonds in excess of their Treasury counterparts have received considerably less attention. Driessen (2005) and Yu (2002) are two of the few (if not the only, to our knowledge) studies that explicitly focus on the expected *excess* returns of the defaultable bonds. The articles utilize the intensity-based frame-work of Duffie and Singleton (1999) with latent variables to study various components of *instantaneous* expected returns

[9] One of the earlier examples in this literature is Campbell and Shiller (1991), but there are many others.

on corporate bonds. Another related study is by Wu and Zhang (2007), who incorporate macro variables into an affine no-arbitrage model of term-structure of Treasuries and credit spreads, although without specifically focusing on expected returns. Our work is thus related to both approaches, since we utilize the macroeconomic variables and model excess returns under the no-arbitrage. However, the methodologies in these papers involve specific assumptions about the functional form of the pricing kernel and dynamics of the underlying factors. While such assumptions are essential in obtaining the closed-form solutions for prices, they may be too restrictive when it comes to examining the informational content of relevant variables. In contrast, the approach taken in our work does not rely on the assumptions about the specific dynamics of the underlying factors, and the pricing kernel and credit premia can be of non-linear form.

Our approach, especially the regression part, is also related to the regression-based studies of determinants of credit spreads. Elton, Gruber, Agrawal and Mann (2001) investigate how expected default losses, tax and risk premia are reflected in credit spreads. They report that expected default losses and differences in tax treatment of Treasury and corporate bonds can not fully account for the observed magnitudes of spreads and that risk premia play an important role to fill the gap. The authors discuss how the differential of log-returns of corporate and government bonds of constant maturity are related to changes in spreads, and argue that a systematic nature of factors affecting returns (three Fama-French factors) supports the idea that corporate bonds command risk premia. This part of their work is similar in spirit to the linear factor models in asset pricing, where sensitivities of returns to *contemporaneous* factors are utilized to explain cross-section of average returns.

Collin-Dufresne Goldstein and Martin (2001) study to what extent changes in credit spreads can be explained by variables that are predicted to be relevant by structural models. They regress changes in credit spreads mainly on concurrent changes and, additionally in a few cases, on lagged levels of the examined variables. The variables included the concurrent and one-month lagged S&P-500 return, introduced to capture business climate and leading effect of stocks on bonds. Given the close relationship between excess returns and changes in spreads utilizing leading variables in such regression is similar in the spirit to our work, although we concentrate on forecasting and explore in more detail the role of macro variables, as well as incorporate the *no-arbitrage* framework at the later stage of the paper.

2 Modeling

The two key technical components in our work are the pricing kernel and the *credit return premium*. In this section we elaborate on how the two are defined and modeled.

2.1 Defining Credit Return Premia

Since previous research has mostly focused on explaining yield spreads and we study excess returns (of defaultable bonds relative to Treasury bonds), in this subsection we discuss the relationship between the two and clarify the meaning of the concept of *credit return premium*.

For simplicity, consider two zero-coupon bonds[10] that mature and pay \$1 at time T. The first bond is defaultable, say corporate bond, with a yield of y_t^c, and the second one is a default-free reference bond, say Treasury bond, with the yield of y_t^r. The yield spread, c_t, is defined as a difference between the two yields:

$$y_t^c = y_t^r + c_t \tag{1}$$

Utilizing definition of yields, properties of logarithms and denoting $(T-t)c_t = -ln(C_t)$, we

[10] In empirical work, we apply the same logic to the coupon-paying bonds.

can rewrite identity (1) in terms of bond prices as

$$P_t^c = P_t^r C_t \tag{2}$$

Therefore, a simple total k-holding-period return on defaultable bond[11], $R_{t+k}^c = \frac{P_{t+k}^c}{P_t^c}$, can be expressed as a multiple of the return on the reference bond

$$R_{t+k}^c = R_{t+k}^r \frac{C_{t+k}}{C_t} \tag{3}$$

We denote it as f_{t+k} and refer to it as the *credit return premium* throughout the paper. In other words, we express defaultable returns in terms of reference returns in the following form

$$R_{t+k}^c = R_{t+k}^r f_{t+k} \tag{4}$$

The term f_{t+k} captures the premium that the defaultable bond pays in excess of the default-free bond. We next discuss how the credit return premia appear in the no-arbitrage forecasting framework.

2.2 Pricing Kernel, Moment Conditions and No-arbitrage

One of the fundamental asset pricing relationships is that under no-arbitrage returns satisfy the Euler equation. The equation states that at time t future discounted returns are expected to be equal to one, and in our context takes the following form:

$$E\big[m_{t+k}\mathbf{R}_{t+k}|\mathcal{F}_t\big] = 1 \tag{5}$$

where $\mathcal{F}_t$ is the information set at time t, $\mathbf{R}_{t+k}$ is a vector of returns $\mathbf{R}_{t+k} \in \mathbb{R}^N$, and m_{t+k} is the stochastic discount factor or the pricing kernel, the object that assigns prices at time

[11]The most appropriate notation for the k-period holding period return would be $R_{t,t+k}$. To simplify notation, here and throughout the rest of the paper, we drop the subscript t whenever we talk about two quintities measured in between t and $t+k$.

t by discounting payoffs at time $t+k$. The pricing kernel reflects investors' risk preferences toward risk or distribution of payoffs across uncertain states of nature.

Applying the law of iterated expectations to the equation (5) yields the moment conditions:

$$E[(m_{t+k}\mathbf{R}_{t+k} - 1) \otimes \mathbf{Z}_t] = 0 \tag{6}$$

where $\mathbf{Z}_t$ is a set of instrumental variables observed by econometrician and belonging to the information set $\mathcal{F}_t$.

We apply the sample version of the set of the moment conditions (6) to two sets of bond returns, which we jointly use in the GMM estimation procedure. The first set of returns consists of treasury returns and the second set consists of credit returns. In essence, we consider two types of moment conditions for reference (Treasury) and credit returns, and they take the following form:

$$\begin{aligned} &E[(m_{t+k}\mathbf{R}^r_{t+1} - 1) \otimes \mathbf{Z}_t] = 0 \\ &E[(m_{t+k}\mathbf{c}_{t+k}\mathbf{R}^c_{t+1} - 1) \otimes \mathbf{Z}_t] = 0 \end{aligned} \tag{7}$$

where $\mathbf{c}_{t+k}$ is a vector, in which each element is the inverse of the *credit return premium*, $c^i_{t+k} = \frac{1}{f^i_{t+k}}$, from equation (4). In other words, the moment conditions for treasury returns will contain only the pricing kernel m_{t+k}, and the moment conditions for credit returns contain both the pricing kernel, m_{t+k}, and the inverse of credit return premium, $\mathbf{c}_{t+k}$. By using the two sets of returns, we are able to jointly identify the parameters of m_{t+k} and $\mathbf{c}_{t+k}$. The economic interpretation is that the time-evolving pricing kernel m_{t+k} captures changes in risk attitudes and discount rates, and the time-variant vector of credit return premia, $\mathbf{c}_{t+k}$, captures changes in riskiness of future cash-flows of defaultable bonds.

2.3 Pricing Kernel and Credit Return Premia: Modeling

Our empirical methodology does not rely on the availability of closed-form solutions for bond prices and allows for flexible, possibly non-linear, specifications of the pricing kernel and credit return premia. For instance, they can be modeled as linear combinations of Hermite polynomials. In the empirical work utilize the first few terms of expansion:

$$m_{t+k}(\mathbf{X}) = \sum_i a_i He_i(\mathbf{X}); \quad c_{t+k}(\mathbf{Y}) = \sum_j b_i He_j(\mathbf{Y}) \tag{8}$$

where $He_i(.)$ are multivariate Hermite polynomials, and $\mathbf{X}$ and $\mathbf{Y}$ are vectors of state variables, we project the pricing kernel and return premia on. $\mathbf{X}$ and $\mathbf{Y}$ may have either common or distinct components[12]. To reduce the dimensionality of the state space, we group the state variables in two categories and form an index or a linear combination of all the variables within each group. Thus, at each moment of time $\mathbf{X}$ and $\mathbf{Y}$ are at most bivariate. The parameters of the functions describing the pricing kernel and credit return premia, and the index weights are estimated jointly. The two groups of variables are the forward rates and the macroeconomic aggregates. We describe them in the next section.

In principle, the pricing kernel m_{t+k} and credit return premia should be functions of the state variables at times t and $t+k$. In this paper we utilize two timing approaches to study informational content of macroeconomic variables. First, we utilize a decomposition of m_{t+k} and c_{t+k} via (conditionally) expected and unexpected components in the following form:

$$m_{t+k} = E(m_{t+k}|\mathcal{I}_t) + \varepsilon_{t+k} \ , \quad E(\varepsilon_{t+k}|\mathcal{I}_t) = 0 \tag{9}$$

$$c_{t+k} = E(c_{t+k}|\mathcal{I}_t) + \eta_{t+k} \ , \quad E(\eta_{t+k}|\mathcal{I}_t) = 0 \tag{10}$$

where $\mathcal{I}_t \subset \mathcal{F}_t$ is the information set consisting of partial or complete information available to econometrician at time t, and ε_{t+k} are innovation terms such that $E(\varepsilon_{t+k}, R_{t+k}|\mathcal{I}_t) \neq$

[12] We deliberately postpone the discussion of timing of $\mathbf{X}$ and $\mathbf{Y}$ until the next paragraph

0 and $E(\eta_{t+k}, R^r_{t+k}|\mathcal{I}_t) \neq 0$. Let us denote $E(m_{t+k}|\mathcal{I}_t)$ as $m^*_{t+k}(\mathbf{X}_t)$ and $E(c_{t+k}|\mathcal{I}_t)$ as $c^*_{t+k}(\mathbf{Y}_t)$, where $\mathbf{X}_t$ and $\mathbf{Y}_t$ are vectors of relevant forecasting variables belonging to the information set $\mathcal{I}_t$. In a part of our empirical work we temporarily impose restrictions on the following unconditional expectations involving a matrix of reference and defaultable returns, $\mathbf{R}_{t+k} = [\mathbf{R}^r_{t+k}\ \mathbf{R}^c_{t+k}]$:

$$E(\varepsilon_{t+k}\mathbf{R}_{t+k} \otimes \mathbf{Z}_t) = 0 \ \text{ and } \ E(m^*_{t+k}\eta_{t+k}\mathbf{R}^r_{t+k} \otimes \mathbf{Z}_t) = 0. \tag{11}$$

Then, unconditional expectations in the moment conditions (6) can be represented as follows:

$$\begin{aligned} &E[(m^*_{t+k}(\mathbf{X}_t)\mathbf{R}^r_{t+k} - 1) \otimes \mathbf{Z}_t) = 0 \\ &E[m^*_{t+k}(\mathbf{X}_t)\mathbf{c}^*_{t+k}(\mathbf{Y}_t)\mathbf{R}^c_{t+k} - 1) \otimes \mathbf{Z}_t) = 0 \end{aligned} \tag{12}$$

With (11) imposed, the GMM-based tests of moment conditions becomes a joint test of average pricing errors and these restrictions, which appear to be unlikely to hold. However, we are not interested in whether the restrictions hold as such, but rather in the additional explanatory power contributed by lagged macro variables, which is captured by the χ^2-test.

In our next step, we project the pricing kernel, m_{t+k} and inverted credit return premia $\mathbf{c}_{t+k}$ on the same factors $\mathbf{X}$ and $\mathbf{Y}$ as before, but measured at time $t+k$. Such timing is consistent with most standard asset pricing models, and we do not need to rely on restrictions in (11). Once we utilize the moment conditions (6) in the GMM estimation procedure, we obtain the parameters governing functions m_{t+k} and $\mathbf{c}_{t+k}$, and the weights of the individual components in the indices of relevant variables (macro and forwards). Estimating the weights of individual components from the Euler equations amounts to extracting relevant information from the array of explanatory variables under the no-arbitrage conditions. After we use the estimated weights to form extracted indices, we investigate to what extent they lead excess returns on defaultable bonds in a new set of forecasting regressions.

3 Data

We utilize monthly one-year holding period returns on US Aggregate Treasury and Credit Indices from the Lehman Brothers Global Family of Indices. The US Aggregate Credit Index is constructed from the investment-grade publicly issued bonds of both corporate and non-corporate sectors[13]. In particular, we secured sub-indices of three maturities: short (1-3 years), intermediate (around 3-5 years) and long (more than 20 years). We view these indices as returns on diversified portfolios of the corresponding debt instruments. Dynkin et al. (2007) discuss the popularity of these indices among fixed income investors and strategies for forming portfolios that replicate their returns. The data sample range is from December 1976 through December 2006. Time-series graphs of data on Treasury and credit one-year holding-period returns are presented in Figure 1.

For forecasting variables, we utilize monthly data from the Federal Reserve Economic Data (FRED) on two sets of macroeconomic variables, or more precisely their standardized growth rates. First, we use nominal macro variables such as CPI for all urban consumers; PPI for finished goods and M2 money stock. Second, we use real macro variables such as industrial production index (IP), non-farm payroll employment (EMPLOY), real personal consumption (PCE) and housing starts (HS). In addition, we use forward rates with horizons of 1 through 5 years, constructed from the unsmoothed Fama-Bliss zero-coupon yields data.

4 Time-series Forecasting Regressions

Our research program consists of two parts. We first estimate forecasting regressions of the following form:

$$R_{t+12} = \mathbf{X}_t \beta + \epsilon_{t+12} \tag{13}$$

[13]The name *US Aggregate Credit Index* motivated the usage of *credit returns* term throughout the paper.

where X_t is the vector consisting of forecasting variables and a constant and $R_{t+12} = \frac{P_{t+12}}{P_t}$ is a 12-month-holding-period return. Thus we are forecasting various one-year-ahead returns utilizing current observations of the right-hand-side variables by separately running individual time-series regressions (with monthly data).

We first present results of forecasting regressions for treasury and credit returns of intermediate (Table 1) and long (Table 2) maturities. For both intermediate and long maturities forward rates possess higher predictive power than macroeconomic variables. However, adding macroeconomic variables does improve adjusted-R^2s of forecasting regressions.

Tables 3 and 4 contain the results of time-series forecasting regressions for excess credit returns (relative to corresponding Treasury returns) of intermediate and long maturities, respectively. In these regressions, the right-hand side variables are current values of the forward rates and macroeconomic variables. The left hand-side variables are the ratios of one-year-ahead credit return and treasury return (for the bonds of the same maturity). Thus, the effects of the interest rate risk on the left-hand side variables are removed. Accordingly, the macroeconomic variables used alone now perform much better than forward rates when used alone. For instance, for intermediate (long) maturities adjusted-R^2s are 36% (12%) when macro-variables are used as forecasters, 10% (3%) when forward rates are used, and 43% (19%) when both sets of variables are utilized.

The results of our forecasting regressions suggest that one-year-lagged macro-economic variables do explain a substantial amount of variation in expected one-year-holding-period returns of Treasury and credit returns. Their relevance becomes even more evident once the influence of interest rate risk is isolated and the excess returns of credit bonds are considered. Our next step is to determine to what extent macroeconomic variable jointly lead and explain returns of various maturities and types (Treasury and credit) when the no-arbitrage restrictions are imposed.

5 Generalized Method of Moments (GMM): Methodology and Results

In this section, we discuss the GMM estimation methodology and results, focusing on the estimated pricing kernel, m_t, and the inverted credit return premia c_t.

5.1 GMM Methodology

To examine the return-forecasting capability of the term-structure and macro variables for both Treasury and credit returns, we construct the following sample moments in our GMM estimation according to equation 6 :

$$[\Theta, \Gamma] = argmin \quad se(\Theta, \Gamma)' W_T se(\Theta, \Gamma) \tag{14}$$

$$se(\Theta, \Gamma) = [se_1(\Theta, \Gamma; \mathbf{X}, \mathbf{Y}), se_2(\Theta; \mathbf{X})] \tag{15}$$

$$se_1(\Theta, \Gamma; \mathbf{X}, \mathbf{Y}) = \frac{1}{T} \sum_{t=1}^{T} \left[(m_{t+12}(\mathbf{X}; \Theta) \mathbf{c}(\mathbf{Y}; \Gamma) \mathbf{R}^c_{t+12} - 1) \otimes \mathbf{Z}_t \right] \tag{16}$$

$$se_2(\Theta; \mathbf{X}) = \frac{1}{T} \sum_{t=1}^{T} \left[(m_{t+12}(\mathbf{X}; \Theta) \mathbf{R}^g_{t+12} - 1) \otimes \mathbf{Z}_t \right] \tag{17}$$

where $\mathbf{R}^c_{t+12}$ is a vector of one-year holding period credit returns, $\mathbf{R}^g_{t+12}$ is a vector of one-year holding period Treasury (government) returns, Θ is a vector of parameters in the pricing kernel, Γ is the vector of parameters governing the credit return premia, $se(.)$ is the vector of sample pricing errors or moment conditions arising from the Euler equation, and $c(.)$ is the inverse of the credit return premium $f(.)$. Note that the time subscript t corresponds to each month, and the annual growth rates of CPI, PPI, M2, IP, EMPLOY, and PCE. Both $\mathbf{X}$ and $\mathbf{Y}$ consist of a pre-determined subset of the term-structure and macro variables. $\mathbf{R}^c_{t+12}$ contains short-, intermediate, and long-term corporate index returns, and $\mathbf{Z}_t$ contains a constant, term-structure, and macro variables.

We assume that the pricing kernel m is linearly dependent on both composite indices of the term-structure and macro variables:

$$m_{t+12}(.) = \theta_0 + \sum_{k=1}^{km} \left(\theta_{0,k} He_k(i_1) + \theta_{0,km+k} He_k(i_2)\right) \quad (18)$$

where $He_i(.)$ are Hermite polynomials.

$$\begin{aligned} i_1 &= \theta_{1,1} y^{(1)} + \theta_{1,2} f^{(2)} + \theta_{1,3} f^{(3)} + \theta_{1,4} f^{(4)} + \theta_{1,5} f_t^{(5)} \\ i_2 &= \theta_{2,1} CPI + \theta_{2,2} PPI + \theta_{2,3} M2 + \theta_{2,4} IP + \theta_{2,5} EMPLOY \\ &\quad + \theta_{2,6} PCE \\ &\quad s.t. \quad \|\theta_1\| = \|\theta_2\| = 1. \end{aligned}$$

The inverse of each credit return premium $c_t^{(i)}$ is specified as a linear projection on either term-structure index, macro index, or both. In order to provide test statistics for the prediction power of the macro variables, we first apply the following equations for the unrestricted estimation:

$$\mathbf{c}_t(\Gamma) = \left[c^{(i)}(.), \quad i = Short, Intermediate, Long\right] \quad (19)$$

$$c^{(i)}(.) = \gamma_0^{(i)} + \sum_{k=1}^{kc} \left(\gamma_{0,k}^{(i)} He_k(i_3) + \gamma_{0,kc+k}^{(i)} He_k(i_4)\right) \quad (20)$$

where

$$\begin{aligned} i_3 &= \gamma_{1,1} y^{(1)} + \gamma_{1,2} f^{(2)} + \gamma_{1,3} f^{(3)} + \gamma_{1,4} f^{(4)} + \gamma_{1,5} f^{(5)} \\ i_4 &= \gamma_{2,1} CPI + \gamma_{2,2} PPI + \gamma_{2,3} M2 + \gamma_{2,4} IP + \gamma_{2,5} EMPLOY + \gamma_{2,6} PCE \\ &\quad s.t. \quad \|\gamma_1\| = \|\gamma_2\| = 1. \end{aligned}$$

For the first restricted model, we assume that each credit return premium (short, intermediate and long maturity) is only dependent on a linear combination of the term-structure variables. The second restricted model only keeps the macro variables in the functional form of each credit return premium. We then estimate these restricted models using the GMM weighting matrix fixed to the optimal variance-covariance matrix of the sample moments in the GMM estimation for the unrestricted model.

5.2 GMM Estimation Results: No-arbitrage, Pricing Kernel and Credit Return Premia

In this section, we present and analyze the GMM estimation results. Table 5 contains partial estimation results for the three versions of the specification (14): the unrestricted one, where both the pricing kernel and credit premia depend on both sets of factors; and the restricted ones, where the credit return premia depend solely on either the term structure or macro variables. Columns 1-2 show the index weights for the two linear combinations of the term-structure and macro variables based on the unrestricted model. The first column presents estimated weights of the forecasting variables in the pricing kernel and shows that the 1-year yield and 5-year forward rate have significant negative effects on the dynamics of the pricing kernel. Among all the macro variables, we find that CPI, PPI, and all the real macro variables are important in predicting future Treasury and credit returns. The second column in Table 5 shows that except the two-year forward rate, all the term-structure and macro variables have statistically significant weights when utilized for joint forecasting of credit return premia. Building on the findings in Cochrane and Piazzesi (2005), we employ 1-year yield and 2-5 year forward rates as the predictors for the first index; the second composite index is a linear combination of all the macro variables. The two estimated indices are negatively correlated (-0.278). Treating the Industrial Production (IP) growth as a business cycle indicator, we find that the estimated term-structure index is counter-cyclical (due to its negative correlation of -0.16 with the IP growth); while the macro index appears to be pro-cyclical (because of its positive correlation with IP growth of 0.13).

Columns 3-4 of Table 5 display estimation results of a model similar to the one in columns 1-2 except that each credit return premium is modeled as a function of only a linear combination of the term-structure variables. We find that only the 1-year yield, CPI, PPI, IP, and EMPLOY are significant components of the pricing kernel. Most of the term-structure variables (except 2-year forward rate) appear to be significant in the linear combination that simultaneously predicts future credit return premia of different maturities.

Columns 5-6 of Table 5 report the results of the second restricted model where each credit return premium is assumed to linearly depend on the macro variables only. In the index of the term-structure variables driving the pricing kernel, the 1-year yield is the only term-structure factor that remains to be important. In the macro index contributing to the dynamics of the pricing kernel, all of the three nominal macro variables and one of the real ones, EMPLOY, significantly affect one-year-ahead bond returns. In addition, we find the index of macro variables forecasting the credit return premia, all the individual components are significant.

By comparing the measures of the overall fit of moment conditions, χ^2 statistics, produced by the three models, we find that both restricted models are rejected in favor of the unrestricted one, which implies that both sets of the term-structure and macro variables are important in predicting the credit return premia. However, the $\chi^2 = 109.11$ indicates that even the unrestricted model is misspecified. Therefore, relaxing linearity restrictions or introducing additional underlying economic factors may enhance the model's return-forecasting power.

Figures 3 and 4 (panel 1-3) presents the monthly time-series model-implied pricing kernel and credit return premia corresponding to the estimates of the unrestricted model in Table 5. The estimated credit return premia appear to be counter-cyclical, as each series is negatively correlated with the real macro variables: IP, EMPLOY and PCE. In particular, we find that these estimated credit risk premia typically increase during the bad times. These results are consistent with the previous findings that default rates increase and recovery rates decrease during recessions.

The previous literature also suggests that investors become more risk-averse during the "bad times". Our results confirm this intuition. In general, our pricing kernel tends to increase before or at the very beginning of each recession and decrease by the end of the period. This can be explained by the fact that we model the pricing kernel as a function of the forward-looking or *leading* economic indicators. The graph also appears to be consistent with the findings of Nieto and Rubio (2007), who utilize several consumption-based models to examine the relationship between the pricing kernel and the business cycles. Interestingly, the pricing kernel estimated utilizing both credit and Treasury returns is highly correlated (0.94) with the one estimated with just Treasury returns[14].

We next determine to what extent the results pertaining to explanatory power of indices depend on timing of the state variables. We consider a case where the pricing kernel, m_{t+k} and inverted credit return premia, $\mathbf{c}_{t+k}$ are functions of state variables at time $t+k$. We also explore the importance of nonlinearities by assuming that the credit return premia functions may include second order Hermite polynomials of the forecasting variables. Table 6 contains the estimated weights in front of the forward rates and macroeconomic variables in both pricing kernel and credit return premia for the model where the pricing kernel is linear, but the credit return premia are quadratic, i.e. depend on both first and second order Hermite polynomials.

In addition, table 6 displays measures of the overall fit of moment conditions of each of the models considered. The macro-economic variables significantly contribute to the model's overall fit of moment conditions. Figures (5) and (6) contain the pricing kernel, $m_{t+12}(\mathbf{X}_{t+12})$, and credit return premia, $\mathbf{f}_{t+12}(\mathbf{Y}_{t+12})$, implied by the model in which the pricing kernel is a linear (1st order Hermite expansion) and the credit return premia are quadratic (2nd order Hermite expansion) functions of state variables at time $t+12$. The basic pattern for the pricing kernel remains the same even after we shift explanatory variables 12 periods forward. It increases right before or at the very beginning of recession.

To gain more insight on how utilizing Euler equations with different timing of explana-

[14]For the latter exercise we actually used returns obtained using Fama-Bliss unsmoothed zero-coupon yields.

tory variables affects the predictive ability of lagged term-structure and macro-economic variables, we apply the constructed term-structure and macro indices as the right-hand-side variables in forecasting regressions. Table 7 contains results of regressions of credit return premia for three maturities on four indices: $\{i_1, i_2\}$ and $\{i_3, i_4\}$, which denote linear combinations of term-structure and macro variables in the pricing kernel and credit return premia, respectively. The first three columns are obtained for the case when the indices are formed based on parameters in table 6 and the next three columns correspond to the case where indices are formed based on parameters in table 5. The explanatory power of the indices, although smaller compared to the case with unrestricted regression parameters, remains quite respectable (reaches roughly 41% for the case of intermediate credit return premium).

6 Conclusion

It is important to understand the sources of variation in excess returns on defaultable bonds. In this paper, we offer a framework that enables us to investigate to what extent (1) macroeconomic variables forecast the future bond returns under no-arbitrage and (2) changes in macro conditions are associated with changes in investors' risk attitudes, discounting rates, and changes in riskiness of future cash flows. Accordingly, we found that (1) macroeconomic variables help in predicting future bond returns even after controlling for the term-structure factors; (2) the pricing kernel increases right before or at the very beginning of recessions, and the credit return premia appear to be countercyclical. The results are consistent with the previous findings that default rates and Treasury bond risk premia (and thus investors' risk aversion) are countercyclical, and that recovery rates are procyclical. In addition, our framework allows using non-linear functional forms to model the credit return premia and the pricing kernel, the feature we have not explored in the current draft. Greater flexibility of non-linear functional forms may prove especially useful in forecasting excess returns on bonds of longer maturities, which tend to have richer dynamics than their shorter-term counterparts.

References

Blume and Keim (1991) "Realized Returns and Defaults on Low-Grade Bonds: The Cohort of 1977 and 1978.", *Financial Analysts Journal* March-April, 63–72

Campbell, J. Y., and R. J. Shiller (1991) "Yield spreads and interest rate movements: a bird's eye view.", *Review of Economic Studies 58*, 495 – 514.

Cochrane, John, H., and Monika Piazzesi (2005) "Bond Risk Premia", *American Economic Review* 95(1), 138–160

Collin-Dufresne, Pierre, Goldstein Robert S. and Martin Spencer J. (2001) "The Determinants of Credit Spread Changes", *Journal of Finance* 56(6), 2177–2207

Driessen, Joost (2005) "Is Default Event Risk Priced in Corporate Bonds?", *Review of Financial Studies* 18, 165–195.

Duffie D. and K. Singleton (1999),"Modeling Term-Structure of Defaultable Bonds", *Review of Financial Studies* 12, 687–720.

Duffie D. and K. Singleton (2003), *Credit Risk: Pricing, Measurement and Management*, Princeton University Press.

Dynkin, Gould, Hyman, Konstantinovsky and Phelps (2007), *Quantitative Management of Bond Portfolios*, Princeton University Press.

Elton, J.E., Gruber, M.J., Agrawal, D. and C. Mann (2001) "Explaining the rate spread on corporate bonds", *Journal of Finance* 56, 247-277.

Fama, E. and Kenneth R. French (1989) "Business Conditions and Expected Returns on Stocks and Bonds", *Journal of Financial Economics*, November, 23–49.

Fons, J. and Kimball (1991) "Corporate Bond Defaults and Default Rate 1970-1990", *Journal of Fixed Income* June, 36-47.

Hackbarth, Dirk, Miao, Jianjun and Erwan Morellec (2006) "Capital Structure, Credit Risk, and Macroeconomic Conditions", *Journal of Financial Economics* 82, 519–550.

Jonsson and Fridson (1996) " Forecasting Default Rates on High-Yield Bonds", *Journal of Fixed Income* June, 69–77.

Ludvigson and Ng (2006) " Macro Factors in Bond Risk Premia", NYU Working Paper.

Nieto, B. and Gonzalo Rubio (2007) "Measuring Time-Varying Economic Fears with Consumption-Based Stochastic Discount Factors", Universitat Pompeu Fabra Working Paper.

Wu Liuren and Frank Xiaoling Zhang (2005) "A No-Arbitrage Analysis of Economic Determinants of the Credit Spread Term Structure", *Management Science*, forthcoming.

Yu, Fan (2002) "Modeling Expected Returns on Defaultable Bonds", *Journal of Fixed Income* September, 69–81.

Tables

Table 1:

Forecasting Regressions: Monthly Credit and Treasury One-year Holding Period Returns (Intermediate Maturity, period Dec. 1976 - Dec. 2006)

The table displays the results of the forecasting regressions of the following form: $R_{t+12} = \mathbf{X}_t\beta + \epsilon_{t+12}$, where R_{t+12} is one-year holding-period return (credit: IntermCr, and Treasury: IntermT), $\mathbf{X}_t$ consists of a constant, rates of growth between $t-12$ and t of the following variables: CPI for all urban consumers, PPI for finished goods, M2 money stock, industrial production index (IP), non-farm payroll employment (EMP), real personal consumption (PCE); and forward rates of 1 through 5-year horizons.

	IntermCr	IntermT	IntermCr	IntermT	IntermCr	IntermT
1-yr yld	–	–	0.71	0.845	2.099	1.825
	–	–	(0.165)	(0.124)	(0.197)	(0.156)
2-yr fwd	–	–	-0.701	0.087	-0.404	0.464
	–	–	(0.655)	(0.49)	(0.591)	(0.469)
3-yr fwd	–	–	-0.149	-0.635	-2.118	-1.875
	–	–	(0.874)	(0.655)	(0.752)	(0.596)
4-yr fwd	–	–	1.023	0.424	1.234	0.293
	–	–	(0.574)	(0.43)	(0.5)	(0.396)
5-yr fwd	–	–	0.71	0.753	1.43	1.214
	–	–	(0.509)	(0.381)	(0.426)	(0.338)
CPI	2.228	1.977	–	–	-0.287	-0.313
	(0.279)	(0.235)	–	–	(0.26)	(0.206)
PPI	-1.484	-1.243	–	–	-0.341	-0.265
	(0.178)	(0.15)	–	–	(0.172)	(0.136)
M2	0.04	0.02	–	–	0.269	0.127
	(0.152)	(0.128)	–	–	(0.124)	(0.099)
IP	0.374	0.038	–	–	0.607	0.246
	(0.153)	(0.129)	–	–	(0.127)	(0.101)
EMP	-1.166	-0.16	–	–	-1.821	-0.734
	(0.338)	(0.285)	–	–	(0.261)	(0.207)
PCE	-0.125	-0.016	–	–	-0.931	-0.643
	(0.3)	(0.253)	–	–	(0.246)	(0.195)
R^2	0.213	0.222	0.332	0.478	0.565	0.619
$\bar{R}^2$	0.2	0.209	0.323	0.47	0.551	0.607

Table 2:

Forecasting Regressions: Monthly Credit and Treasury One-year Holding Period Returns (Long Maturity, period Dec. 1976 - Dec. 2006)

The table displays the results of the forecasting regressions of the following form: $R_{t+12} = \mathbf{X}_t\beta + \epsilon_{t+12}$, where R_{t+12} is one-year holding-period return (credit: LongCredit , and Treasury: LongTreas), $\mathbf{X}_t$ consists of a constant, rates of growth between $t-12$ and t of the following variables: CPI for all urban consumers, PPI for finished goods, M2 money stock, industrial production index (IP), non-farm payroll employment (EMP), real personal consumption (PCE); and forward rates of 1 through 5-year horizons.

	LongCredit	LongTreas	LongCredit	LongTreas	LongCredit	LongTreas
1-yr yld	–	–	0.503	0.438	2.971	2.735
	–	–	(0.306)	(0.336)	(0.377)	(0.441)
2-yr fwd	–	–	-2.308	-1.106	-1.622	0.634
	–	–	(1.212)	(1.332)	(1.129)	(1.322)
3-yr fwd	–	–	-1.134	-2.665	-4.57	-5.877
	–	–	(1.619)	(1.779)	(1.436)	(1.68)
4-yr fwd	–	–	2.725	2.407	3.104	1.79
	–	–	(1.062)	(1.168)	(0.955)	(1.117)
5-yr fwd	–	–	2.36	2.907	3.559	3.752
	–	–	(0.942)	(1.036)	(0.813)	(0.952)
CPI	2.703	2.426	–	–	-0.856	-1.05
	(0.485)	(0.533)	–	–	(0.497)	(0.582)
PPI	-2.116	-2.18	–	–	-0.365	-0.664
	(0.31)	(0.341)	–	–	(0.329)	(0.385)
M2	0.067	-0.232	–	–	0.606	0.117
	(0.264)	(0.29)	–	–	(0.238)	(0.278)
IP	0.719	0.308	–	–	1.048	0.601
	(0.267)	(0.293)	–	–	(0.243)	(0.285)
EMP	-1.665	-0.44	–	–	-2.656	-1.449
	(0.588)	(0.646)	–	–	(0.499)	(0.584)
PCE	-0.582	-0.184	–	–	-1.954	-1.213
	(0.522)	(0.574)	–	–	(0.469)	(0.549)
R^2	0.153	0.113	0.185	0.147	0.435	0.33
$\bar{R}^2$	0.139	0.098	0.174	0.135	0.418	0.309

Table 3:

Forecasting Regressions: Monthly Credit Return Premium (Intermediate Maturity, period: Dec. 1976 - Dec. 2006)

The table displays the results of the forecasting regressions of the following form: $f_{t+12} = \mathbf{X}_t\beta + \epsilon_{t+12}$, where $f_{t+12} = \frac{R^c_{t+12}}{R^g_{t+12}}$ is the ratio of total simple credit and Treasury one-year holding-period returns on bonds of intermediate maturity; $\mathbf{X}_t$ consists of a constant, rates of growth between $t-12$ and t of the following variables: CPI for all urban consumers, PPI for finished goods, M2 money stock, industrial production index (IP), non-farm payroll employment (EMP), real personal consumption (PCE); and forward rates of 1 through 5-year horizons.

	Credit Return Premium (interm.)	Credit Return Premium (interm.)	Credit Return Premium (interm.)
1-yr yld	–	-0.154	0.208
	–	(0.057)	(0.067)
2-yr fwd	–	-0.716	-0.77
	–	(0.226)	(0.2)
3-yr fwd	–	0.458	-0.21
	–	(0.301)	(0.254)
4-yr fwd	–	0.512	0.829
	–	(0.198)	(0.169)
5-yr fwd	–	-0.017	0.207
	–	(0.175)	(0.144)
CPI	0.177	–	0.006
	(0.075)	–	(0.088)
PPI	-0.198	–	-0.059
	(0.048)	–	(0.058)
M2	0.017	–	0.124
	(0.041)	–	(0.042)
IP	0.309	–	0.332
	(0.041)	–	(0.043)
EMP	-0.927	–	-0.991
	(0.091)	–	(0.088)
PCE	-0.084	–	-0.24
	(0.081)	–	(0.083)
R^2	0.367	0.117	0.448
$\bar{R}^2$	0.356	0.104	0.43

Table 4:

Forecasting Regressions: Monthly Credit Return Premium
(Long Maturity, period: Dec. 1976 - Dec. 2006)

The table displays the results of the forecasting regressions of the following form: $f_{t+12} = \mathbf{X}_t\beta + \epsilon_{t+12}$, where $f_{t+12} = \frac{R^c_{t+12}}{R^g_{t+12}}$ is the ratio of total simple credit and Treasury one-year holding-period returns on bonds of long maturity; $\mathbf{X}_t$ consists of a constant, rates of growth between $t-12$ and t of the following variables: CPI for all urban consumers, PPI for finished goods, M2 money stock, industrial production index (IP), non-farm payroll employment (EMP), real personal consumption (PCE); and forward rates of 1 through 5-year horizons.

	credit return premium (long)	credit return premium (long)	credit return premium (long)
1-yr yld	–	-0.052	0.098
	–	(0.104)	(0.139)
2-yr fwd	–	-1.011	-1.909
	–	(0.412)	(0.417)
3-yr fwd	–	1.266	1.082
	–	(0.55)	(0.53)
4-yr fwd	–	0.321	1.16
	–	(0.361)	(0.352)
5-yr fwd	–	-0.354	-0.06
	–	(0.32)	(0.3)
CPI	0.176	–	0.131
	(0.153)	–	(0.184)
PPI	0.019	–	0.259
	(0.098)	–	(0.121)
M2	0.262	–	0.427
	(0.083)	–	(0.088)
IP	0.297	–	0.348
	(0.084)	–	(0.09)
EMP	-0.97	–	-0.942
	(0.186)	–	(0.184)
PCE	-0.284	–	-0.617
	(0.165)	–	(0.173)
R^2	0.139	0.041	0.217
$\bar{R}^2$	0.124	0.028	0.192

Table 5:

GMM estimation results on the term-structure and macro variables

The table displays the results of the factor loadings based on the GMM estimation of the following moment conditions: $E\{m(\mathbf{X}_t\beta)\left[c(\mathbf{Y}_t\gamma)R^c_{t+12}, \quad R^g_{t+12}\right] - \mathbf{1}|\mathbf{Z}_t\} = 0$, where R^c_{t+12} and R^g_{t+12} are the total simple credit and Treasury one-year holding-period returns on bonds; $\mathbf{X}_t$ and $\mathbf{Y}_t$ contain a constant, 1-year yield, 2-5 year forward rates, and annual growth rates of the following variables: CPI for all urban consumers, PPI for finished goods, M2 money stock, industrial production index (IP), non-farm payroll employment (EMP), real personal consumption (PCE).

	Model 1		Model 2		Model 3	
	PKernel	CPremium (Inversed)	PKernel	CPremium (Inversed)	PKernel	CPremium (Inversed)
1-yr yld	-0.953	-0.178	-0.993	0.097	-0.995	
	(0.041)	(0.028)	(0.018)	(0.022)	(0.016)	
2-yr fwd	-0.096	0.022	-0.028	0.097	0.052	
	(0.187)	(0.092)	(0.169)	(0.087)	(0.174)	
3-yr fwd	0.074	0.765	0.036	0.438	0.282	
	(0.157)	(0.036)	(0.177)	(0.085)	(0.194)	
4-yr fwd	-0.091	-0.381	-0.101	-0.864	-0.066	
	(0.174)	(0.066)	(0.167)	(0.027)	(0.146)	
5-yr fwd	-0.262	-0.488	-0.042	0.206	0.05	
	(0.128)	(0.056)	(0.138)	(0.058)	(0.115)	
CPI	-0.236	0.207	-0.161		-0.609	0.779
	(0.072)	(0.041)	(0.076)		(0.05)	(0.076)
PPI	0.211	-0.085	0.171		0.534	-0.201
	(0.064)	(0.025)	(0.057)		(0.036)	(0.017)
M2	-0.07	-0.087	0.061		0.16	0.06
	(0.037)	(0.014)	(0.032)		(0.032)	(0.02)
IP	-0.297	-0.31	-0.226		-0.005	0.2
	(0.028)	(0.011)	(0.027)		(0.032)	(0.021)
EMPLOY	0.656	0.858	0.943		0.564	-0.353
	(0.076)	(0.017)	(0.022)		(0.037)	(0.017)
PCE	0.614	0.333	0.038		-0.022	-0.431
	(0.081)	(0.041)	(0.071)		(0.074)	(0.04)
χ^2	109.1105		442.09		710.568	
$d.f.$	331		339		337	

Table 6:

GMM estimation results on the term-structure and macro variables

The table displays the results of the factor loadings based on the GMM estimation of the following moment conditions: $E\{m(\mathbf{X}_{t+12}\beta)\left[c(\mathbf{Y}_{t+12}\gamma)R^c_{t+12}, \quad R^g_{t+12}\right] - \mathbf{1}|\mathbf{Z}_t\} = 0$, where R^c_{t+12} and R^g_{t+12} are the total simple credit and Treasury one-year holding-period returns on bonds; **X** and **Y** contain a constant, 1-year yield, 2-5 year forward rates, and annual growth rates of the following variables: CPI for all urban consumers, PPI for finished goods, M2 money stock, industrial production index (IP), non-farm payroll employment (EMP), real personal consumption (PCE).

	Model 1		Model 2		Model 3	
	PKernel	CPremium (Inversed)	PKernel	CPremium (Inversed)	PKernel	CPremium (Inversed)
1-yr yld	0.366	-0.269	0.351	0.167	0.398	
	(0.152)	(0.028)	(0.141)	(0.01)	(0.141)	
2-yr fwd	-0.632	0.59	-0.584	-0.443	-0.53	
	(0.454)	(0.032)	(0.52)	(0.02)	(0.407)	
3-yr fwd	-0.502	-0.711	-0.614	0.719	-0.503	
	(0.871)	(0.027)	(0.741)	(0.025)	(0.814)	
4-yr fwd	-0.417	0.174	-0.399	0.076	-0.492	
	(0.565)	(0.084)	(0.59)	(0.045)	(0.534)	
5-yr fwd	-0.201	0.208	-0.004	-0.503	-0.256	
	(0.523)	(0.071)	(0.377)	(0.032)	(0.523)	
CPI	0.674	0.611	0.879		0.649	0.617
	(0.255)	(0.045)	(0.063)		(0.23)	(0.028)
PPI	-0.157	-0.487	-0.342		-0.09	-0.695
	(0.084)	(0.045)	(0.084)		(0.095)	(0.045)
M2	-0.31	0.267	-0.073		-0.31	0.21
	(0.1)	(0.033)	(0.089)		(0.084)	(0.055)
IP	0.393	-0.152	0.315		0.305	-0.053
	(0.095)	(0.063)	(0.114)		(0.118)	(0.089)
EMPLOY	-0.138	0.233	0.053		-0.284	-0.113
	(0.173)	(0.078)	(0.217)		(0.215)	(0.071)
PCE	0.501	-0.49	0.048		0.55	-0.277
	(0.265)	(0.045)	(0.245)		(0.023)	(0.187)
χ^2	96.96		419.676		496.559	
$d.f.$	331		339		338	

Table 7:

Forecasting Regressions of Credit Risk Premia (Dec. 1976 - Dec. 2006)

The table displays the results of the forecasting regressions of the following form: $r_{t+12} = \mathbf{I}_t\beta + \epsilon_{t+12}$, where $r_{t+12} = \frac{R^c_{t+12}}{R^g_{t+12}}$ are the ratios of total simple credit and Treasury one-year holding-period returns; $\mathbf{I}_t$ consists of a constant and index factors composed by the factor loadings in table 5. I.e. $\mathbf{I}_t = [i1, i2, i3, i4]$, where $i1$ is the term-structure index composite factor extracted from the model of pricing kernel, $i2$ is the macro index composite factor from the model of pricing kernel; $i3$ is the term-structure index factor composed from the model of credit return premia, and $i4$ is the macro index factor implied by the credit return premia.

	short	intermediate	long	short	intermediate	long
	$R_{t+12} = const. + \beta_1 i_{1t} + \beta_2 i_{2t} + \beta_3 i_{3t} + \beta_4 i_{4t} + \epsilon_{t+12}$					
const.	1.015	1.018	1.007	1.015	1.017	1.002
	(0.002)	(0.004)	(0.007)	(0.002)	(0.003)	(0.006)
$i1$	0.034	0.021	-0.079	-0.006	-0.024	-0.182
	(0.016)	(0.028)	(0.053)	(0.025)	(0.04)	(0.089)
$i2$	0.002	0.003	0.005	-0.094	-0.098	0.616
	(0.000)	(0.000)	(0.001)	(0.075)	(0.122)	(0.268)
$i3$	0.138	0.15	-0.533	-0.327	-0.995	-0.421
	(0.12)	(0.21)	(0.4)	(0.131)	(0.212)	(0.468)
$i4$	0.129	0.135	0.006	-0.384	-0.923	-1.58
	(0.05)	(0.088)	(0.166)	(0.094)	(0.152)	(0.335)
R^2	0.204	0.178	0.095	0.309	0.409	0.105
$\bar{R}^2$	0.195	0.169	0.085	0.301	0.403	0.095

Figures

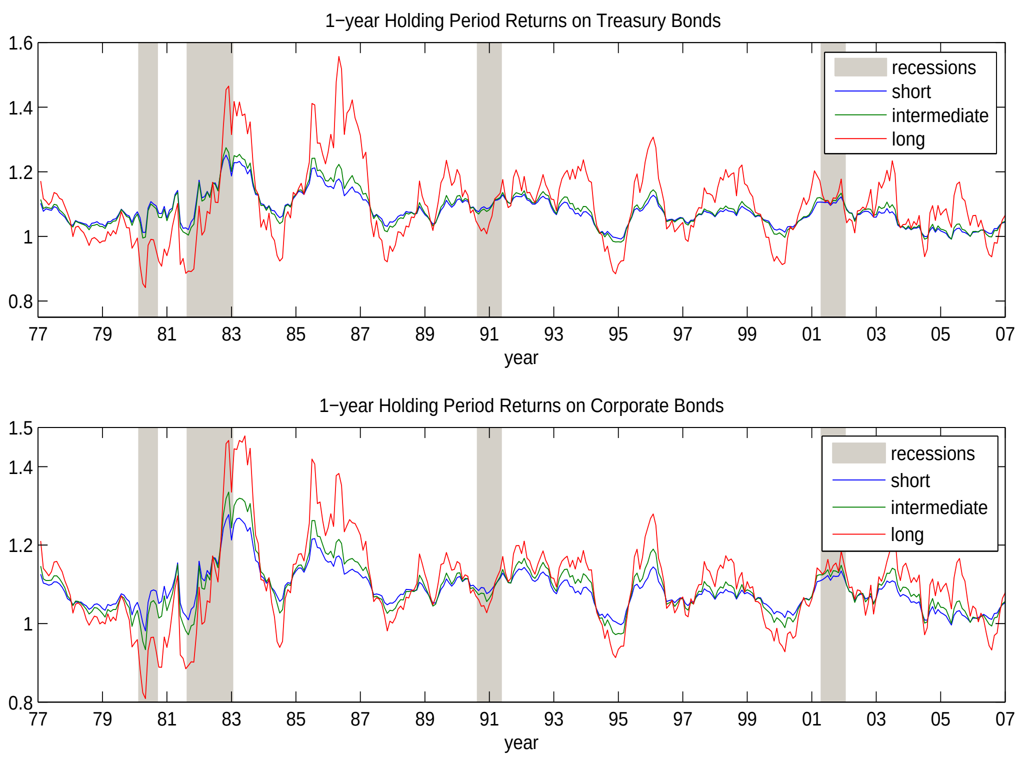

Figure 1: **Time Series of Treasury and Credit Index One-Year Holding Period Returns**

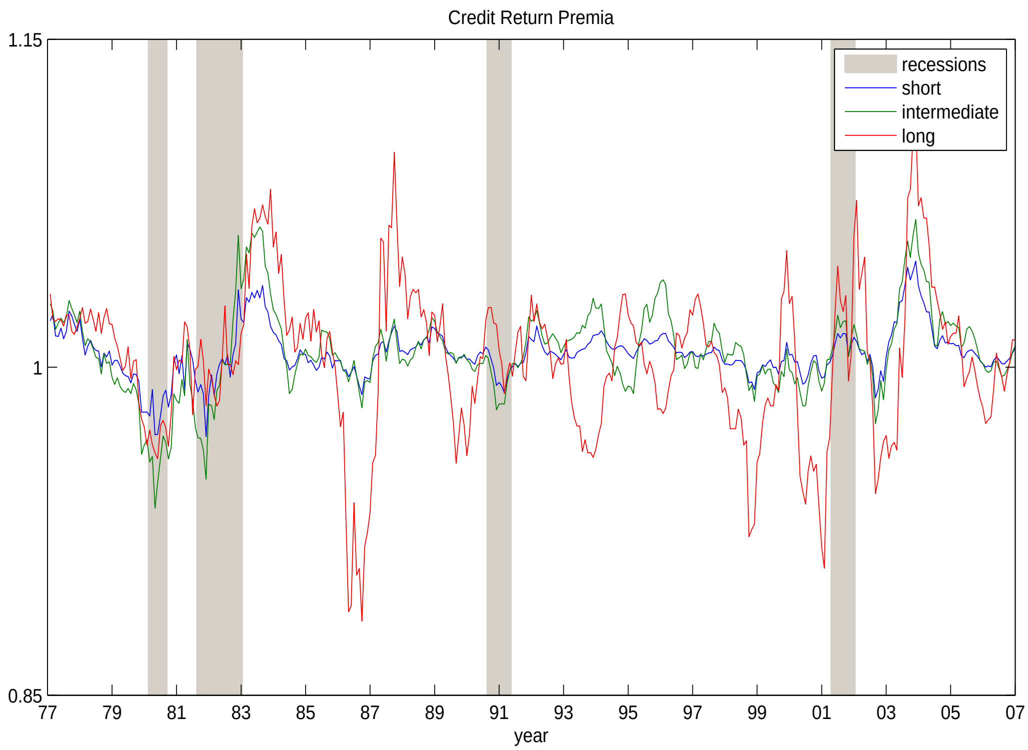

Figure 2: **Time Series of Sample Credit Return Premia**

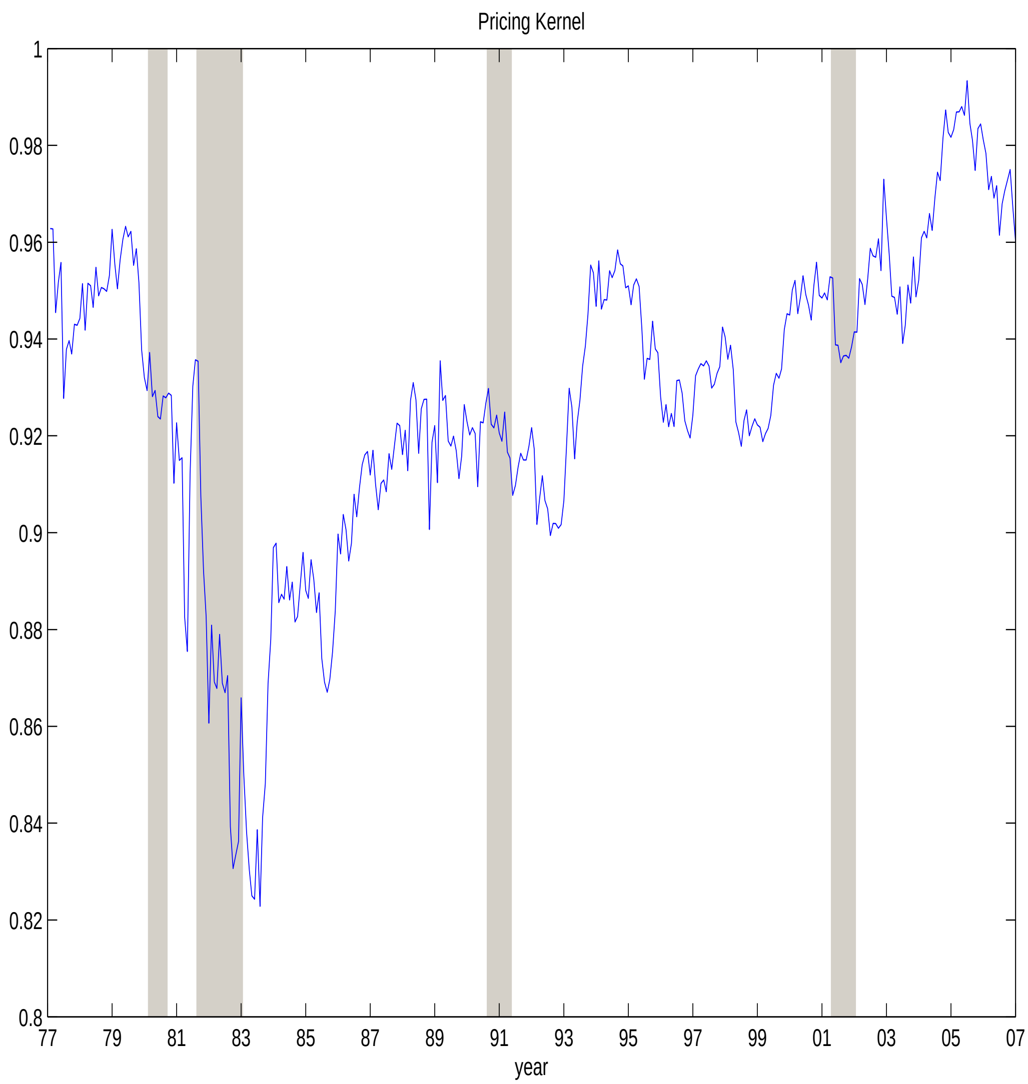

Figure 3: **Time Series Model-implied (Linear) Pricing Kernel (Model with Linear Credit Premia)**

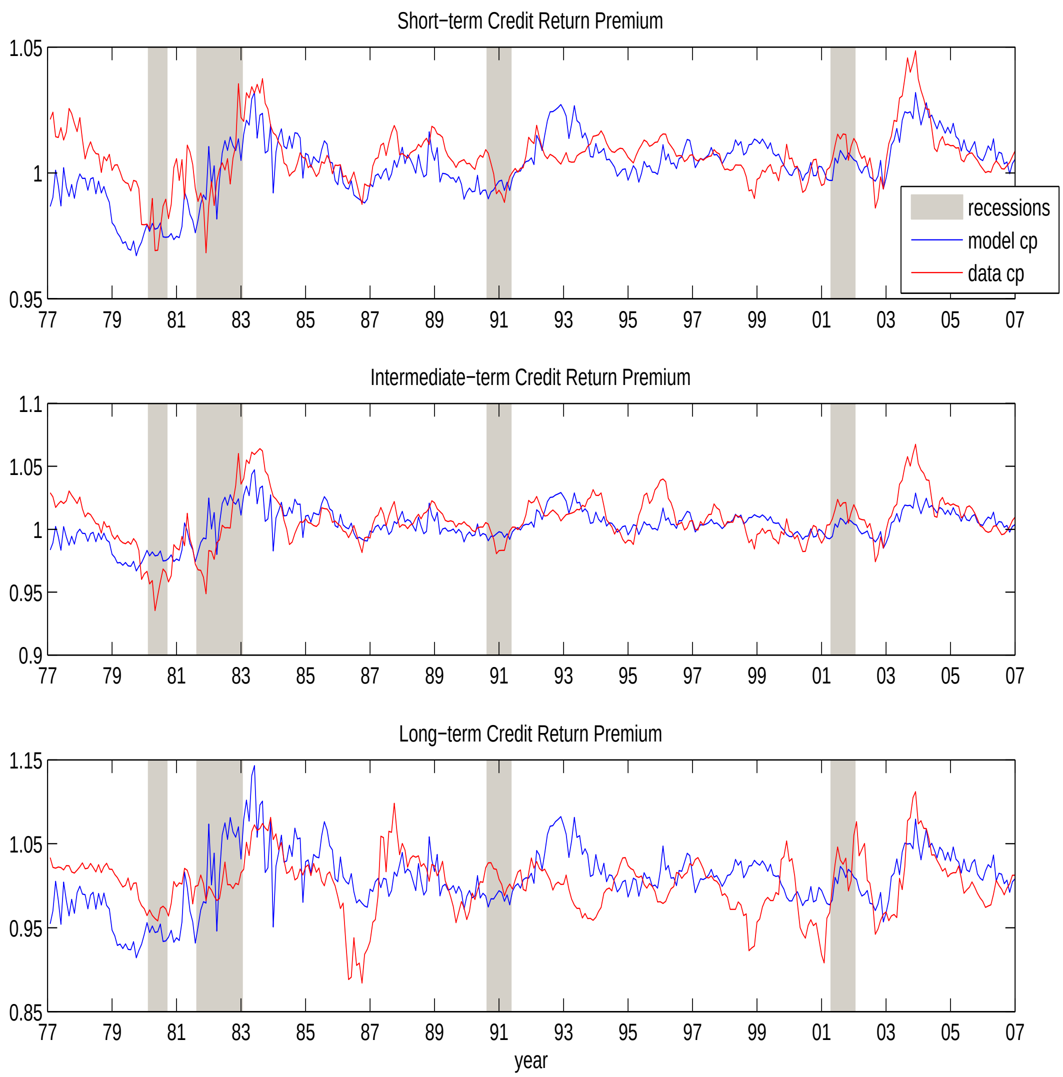

Figure 4: **Time Series Model-implied (Expected) and Data-Based (Realized) Return Premia on Defaultable Bonds (Model with Linear Pricing Kernel and Premia)**

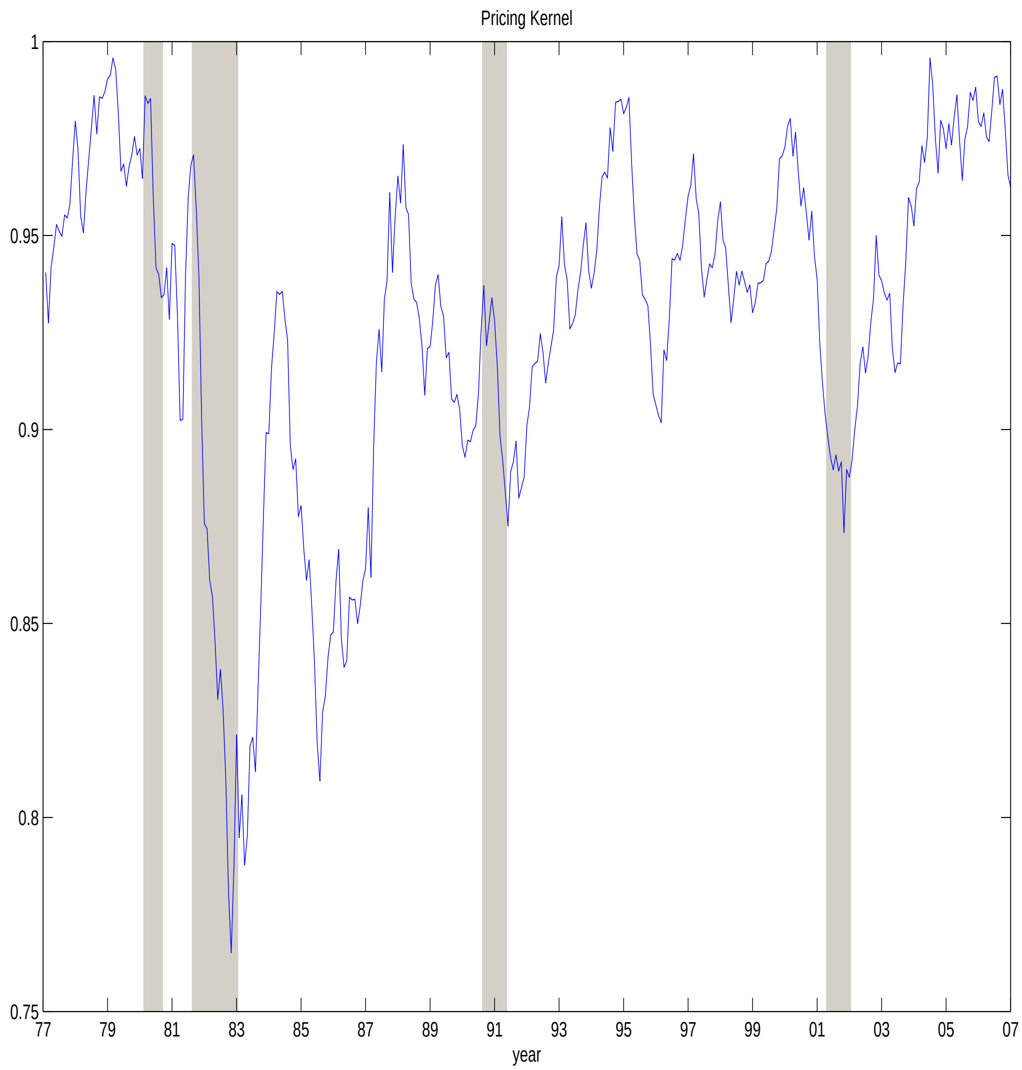

Figure 5: **Time Series of Pricing Kernel Implied by the Model in which the Pricing Kernel and the Credit Return Premia are Linear Functions of State Variables at time $t + 12$.**

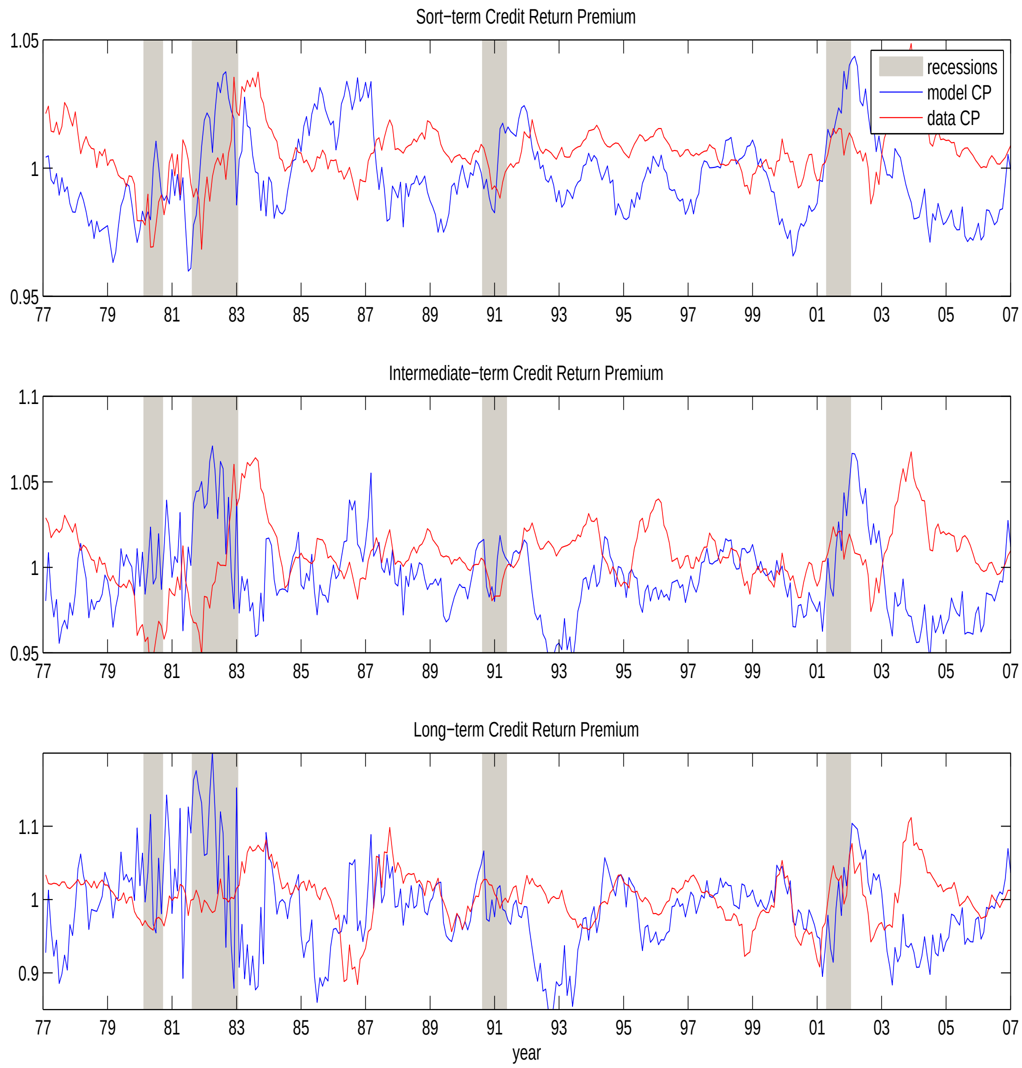

Figure 6: **Time Series of Credit Return Premia Implied by the Model in which the Pricing Kernel and the Credit Return Premia are Linear Functions of State Variables at time $t + 12$.**