Information in the Corporate and Term Spreads: A Macro-Financial Approach*

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Abstract

This paper investigates the forecasting potential of the corporate and term spreads for real activity. To this end, we build an affine term structure model, jointly pricing corporate and government bonds conditional on a set of macroeconomic and financial factors. The forecasting power of the corporate and term spread is evaluated using the model-implied R^2s of the standard predictive regressions. The model is estimated on US data using MCMC methods. The results corroborate the view that the term spread has lost most of its forecasting power since the beginning of the 1990's. Furthermore, the population R^2s suggest that corporate spreads are useful in forecasting real activity for horizons up to 12-months. The forecasting power of the corporate bond spreads is mainly concentrated in long-term bonds with an intermediate-risk profile, i.e. BBB-rated bonds.

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1 Introduction

Predicting the future level of real activity is important for different types of economic agents like business firms or central governments. In this context, financial variables have received particular attention by economists and forecasters. Because of their forward-looking nature, variables such as the term spread[1] - that is, the difference between the interest rates on long and short-term government debt instruments - or the default spreads - that is, the difference between the interest rates on defaultable debt instruments and government bonds of matched maturities- or short-term interest rates are often used as predictors of future economic activity.

Two of the most studied financial indicators are the term spreads and the default spreads, which are also the focus of this paper. For both instruments, their predictive power is grounded on economic arguments. First, as implied by the expectations hypothesis of the term structure of interest rates, the yield spread is an indicator of the future expected short-term interest rate changes. If investors expect the future short rate to fall, the yield curve flattens or inverts. Therefore, if monetary authority stabilizes output growth, a contractionary monetary flattens (or inverts) the yield curve because investors expect the short-term interest rate to decrease once economic activity has slowed down. Second, the financial accelerator theory of Bernanke and Gertler (1989) provides a direct link between real activity developments and the spread between defaultable and risk-free bonds. A key concept of the financial accelerator mechanism is the external finance premium, i.e. the cost that a borrower faces in raising the funds externally rather than internally, which is often proxied by the corporate bond spread. A rise in this premium makes borrowing more costly and therefore reduces investments and aggregate output.

Both spreads have received considerable attention in the economic literature. Since the seminal work of Laurent (1988), Laurent (1989) Stock and Watson (1989), Chen (1991) and Estrella and Hardouvelis (1991), a large literature has investigated the predictive power of term spread, with the overall conclusion that the term spread constitutes a useful piece of information in forecasting future levels of real activity.[2] Examples of studies analyzing the forecasting power of the credit spread are Gertler and Lown (1999), Chan-Lau and Ivaschenko (2002), Mueller (2009), and Gilchrist et al. (2009). The overall conclusions of these studies are that (i) corporate spreads are useful instruments for forecasting real activity at 6– to 18–months horizons(Chan-Lau and

[1] In this paper we will use the terminology yield spread and term spread interchangeably.

[2] Other examples are the studies of Estrella and Mishkin (1997), Estrella and Mishkin (1998), and Hamilton and Kim (2002).

Ivaschenko (2002)), (ii) spreads on intermediate-risk companies are to be preferred over spreads on high risk ones for forecasting real activity (Gilchrist et al. (2009)) and (iii) spreads on long term bonds are more informative than those on short term ones in predicting future economic activity (Mueller (2009), and Gilchrist et al. (2009)).

Despite the large amount of papers analyzing the information content of the term and corporate spread, some issues have received only less attention. First, given the evidence of parameter instability pointed out by Stock and Watson (2003) among others, it is unclear whether the term spread is still a valuable source of information for forecasting future real activity. The issue has recently been pointed out by Ang et al. (2006), who report that the predictive ability of the term spread appears to be concentrated around the 70's and 80's, while it disappears in the 90's. Second, notwithstanding the strong evidence in favor of the corporate spread as an information variable for the future real activity, it is still not clear (i) for which forecasting horizon the information in this type of spread is more useful and (ii) which maturity or rating class of the corporate spread should be used for forecasting purposes.

In this paper we address these two issues by building a medium-scaled macro-finance model integrating corporate spread factors (i.e. determinants of the external finance premium) into an otherwise standard Macro-finance framework. This allows us to derive the population R^2s of the forecasting regressions and to conduct the analysis in a unified and consistent (no-arbitrage) framework. As pointed out by Ang et al. (2006), this approach has at least two advantages over the unrestricted OLS. First, it characterizes the information content of any possible term and corporate spread, even those for which no data is available. Second, it provides a more robust characterization of the forecasting ability of the spreads because the population R^2s can be interpreted as the average R^2s that one would get if it were to run the forecasting regressions a large amount of time on different datasets.

In our model, government and corporate bonds are priced by a set of three macroeconomic factors, three latent factors with financial interpretation and one stochastic trend. Although closely related to the model of Mueller (2009), our work has at least three distinctive features. First, we give a clear interpretation to the extracted latent factors, which are a return generating factor for the government bonds and a common and a rating-specific factor for the corporate spreads. The identification is performed by imposing a hierarchical structure on the pricing of the bonds and by modeling the one-period risk premia using only a limited set of factors. Second, we derive theoretical R^2s for the forecasting regressions and provide a formal comparison of the forecasting power of term and corporate spreads. Third, we estimate the model in a Bayesian setting, along the lines of Chib and Ergashev (2009) and Chib and Ramamurthy (2010). Using a Bayesian approach has several advantages, such as allowing to set prior information on the parameters of the model based on economic considerations and to derive the error bands for the theoretical R^2s.

Our findings are summarized as follows. First, the information in the term spread is limited and mainly concentrated in the 12- and 60-months forecasting horizon. When we add the term spread to a baseline regression with the current level of real activity and the short-term risk-free rate, the increase in R^2s is marginal, regardless the forecasting horizon and the maturity of the spreads. Second, long-term corporate spreads forecast short-term dynamics of real activity better than any term spread. Adding the BBB spreads (B spread) to the baseline regression results in a higher increase in R^2s in the short-term (3- to 12-months) forecasting horizons than when the term spread is added. Controlling for the term spread does not alter this conclusion. Finally, through an analysis of the information content of corporate spreads, we find that investment grade spreads are more informative than non investment ones', with most of the forecasting power concentrated on short-term horizons and on spreads of long maturities (120-months).

The remainder of the paper is organized as follows. In the next section, we briefly analyze the information content of the term and corporate spreads by means of standard least square techniques and show that the uncertainty related to these forecasts is considerable. In section 3, we present the affine model for corporate and government bonds as well as the identification restrictions for the latent factors and the stochastic trend. Section 4 outlines the econometric framework adopted for the estimation of the model and the derivation of the population R^2s. In section 5, we present our main findings and in section 6 we conclude.

2 Predicting Economic Activity: Stylized Facts

In this section we review the forecasting power of the government term spreads and corporate spreads with respect to real activity. We first present the data used for measuring real activity, government yields and corporate spreads. Subsequently, we assess the information content of the government yields and corporate spreads with respect to future levels of real activity.

2.1 Data

We base our analysis on monthly US data from 1992:5 to 2010:1. We use three blocks of data: real activity-related data (4 series), zero-coupon government bond yields (6 series) and corporate bond yield spreads (12 series). In the remainder of the section, we present our measure of real activity and discuss some salient properties of the zero-coupon government yields and of the corporate spreads.

Real activity measure

Following Ang and Piazzesi (2003), we measure real activity (g_t) as the first principal component of four variables:[3] unemployment (g_t^U, obtained from FRED), the year-by-year growth rate of employment (g_t^E, obtained from FRED), the year-by-year growth rate of industrial production (g_t^{IP}, retrieved from FRED) and the Index of Help Wanted Advertising in Newspapers (g_t^{HELP}, obtained from FRED).[4] The top panel of Table 1 reports the loadings of the four principal components and the cumulative fraction of variance explained. The figures reported in the table indicate that g_t not only summarizes most of the information contained in the original series, but can also be interpreted as a measure of real activity. Indeed, the first principal component loads positively on g_t^{IP}, g_t^E and g_t^{HELP} but negatively on g_t^U, implying that positive shocks to g_t^U are associated with worsening in economic conditions. Furthermore, g_t alone explains 72 % of the variation in the original series, implying that the bulk of the variation in the original series can be captured by a single common factor. A plot of the real activity measure is reported in the top panel of Figure 1.

Insert: Table (1) and Figure (1)

Government bond yields

We use data on zero-coupon government bonds, $y_{gov,t}(m)$, of maturities $m = 3-, 12-, 36-, 60-, 84-$ and $120-$months (source: Bloomberg[5]). Table 2, which reports the salient statistics of the government yields, highlights that: (i) the unconditional average yield curve is upward-sloping, with the sample mean monotonically increasing from 3.56% ($3-$month yields) to 5.24% ($120-$month

[3] More formally, we fisrt normalize the original series and then take their first principal component as a measure of real activity.

[4] All growth rates are the difference between the logarithm of the index at time t and the logarithm of the index at time t-12.

[5] The zero-coupon yields $y_{gov,t}(3)$ are retrieved directly from Bloomberg while the $12-, 36-, 60-, 84-$ and $120-$month yields are obtained by stripping the par yields of the Fair Market Value (FMV) curve of Bloomberg.

yields); (ii) the unconditional volatility of yields is downward sloping, with a standard deviation decreasing from 1.86% (3−month yields) to 1.17% (120−month yields); and that (iii) yields are highly persistent, with the one lag autocorrelation ranging form 0.97 (84− and 120−month yields) to 0.99 (3− and 12−month yields). The second panel of Figure 1 displays the time series of the 12−, 60− and 120−month yields.

Insert: Table (2)

Corporate bond yield spreads

We construct the credit spreads as the difference between the zero-coupon corporate bond yields of 3−, 12−, 36−, 60−, 84− and 120−months maturities (source: Bloomberg[6]) and the zero-coupon government bond yields of corresponding maturities:

$$s_{j,t}(m) = y_{j,t}(m) - y_{gov,t}(m), \qquad j = BBB, B$$

where $y_{j,t}(m)$ is the zero-coupon yield of the j-rated corporate bond and $s_{j,t}(m)$ is the correspondent spread. Following Amato and Luisi (2006), we concentrate on the investments grade and non-investment grade rating classes for industrial firms, which are among the broadest and deepest rating-sector categories in the US. A plot of the 12−, 60− and 120−month BBB and B spreads is depicted on Figure 1. The top panel of Table 2 suggests that average spreads increase with maturity and are higher for lower rated bonds. For example, across maturity the B-rated spreads are on average 4.1% while the BBB-rated spreads are on average 2.9%. The bottom panel of Table 2 highlights that the corporate spreads are negatively correlated with government yields (the average correlation is -59%), suggesting that movements of the government yields curve are not directly and fully transmitted to the corporate bond yields curve or viceversa, as highlighted by Duffee (1998). Furthermore, the same panel shows that there is a strong negative correlation between real activity and corporate bond spreads (on average -75%).

The strong correlation between real activity and corporate spreads suggests that there is a link between economic activity and credit spreads, with the credit spreads decreasing as economic conditions improve. Next section further investigates this link and assesses the forecasting power of the term spread.

[6]Following Mueller (2009), yields on corporate bonds are obtained by stripping the FMV yield curve of Bloomberg.

2.2 Predicting Economic Activity

While the bulk of the literature concentrates on forecasting the growth of real activity (see Mueller (2009), Gilchrist et al. (2009) and Ang et al. (2006), among others), we follow Chan-Lau and Ivaschenko (2002) and focus our analysis on forecasting the marginal growth of real activity, which is the year-to-year change in a real activity index. Our starting point is the following predictive regression:

$$g_{t+h} = \alpha_h(m) + \lambda_h g_t + \gamma_h y_{gov,t}(3) + \beta_h s_{gov,t}(m) + \delta_h s_{j,t}(m) + e_{t+h}, \tag{1}$$

where our measure of marginal growth of real activity, g_{t+h}, is regressed (i) on the 3-month risk-free rate, $y_{gov,t}(3)$;[7] (ii) on the term spread of the government yields curve, $s_{gov,t}(m) = y_{gov,t}(m) - y_{gov,t}(3)$; (iii) on the credit spread for a j-rated bond of maturity m (j= BBB, B), $s_{j,t}(m)$; and (iv) on the current level of real activity, g_t. Based on Eq. (1), we perform four types of regressions. The first model (Model I) assesses the information content of the current level of the real activity and of the short-term risk-free rate. Given the strong level of autocorrelation in the real activity series and the findings of Ang et al. (2006), we expect this variable to perform well in forecasting g_{t+h}. In the second model (Model II), we analyze the forecasting power of the term spread. Specifically, we add the spread between the long and short term government yield, $s_{y,t} = y_{gov,t}(120) - y_{gov,t}(3)$[8], which is commonly referred to as the "slope factor". In Model III and IV, we asses the incremental information contained in the corporate spreads. This is accomplished by adding to Model II the 120-month BBB and the 120-month B spreads, respectively.

Insert: Table 3

Table 3 reports the empirical R^2s and the bootstrapped error bands[9] of the four respective models.

For Model I the point estimate of the R^2 at the 3-months forecasting horizon is equal to 90%.

[7] We follow Gilchrist et al. (2009) and convert the nominal yields in real term.in order to take into account the possible non stationarity in the level nominal yields.

[8] Given the results of Ang et al. (2006) we focus our introductory analysis on the spread between long-term (120-months) and short-term rate. Also for the corporate spreads, in this introductory analysis we exploit the findings of Gilchrist et al. (2009) and report only the results for the long-term corporate spreads.

[9] We focus on the R^2. Given the lenght of the series and the small number of control variables, the difference between R^2 and Adj-R^2 is minimal. Furthermore, given the strong persistence in the error terms of the regressions based on Eq. (1), we used a block bootstrap procedure. We determined the size block by using the procedure proposed by Politis and White (2004).

This implies that the current level of real activity and the short rate are important information variables for the immediate future level of real activity. Adding the slope of the government yield curve to the regression results in an increase in the 24- to 60-months R^2s of 15 to 35 percentage points. However, the large error bands demonstrate the imprecision of these estimates, an issue that has already been pointed out by Ang et al. (2006), who report for their regressions ranges for the error bands of the empirical R^2s as high as 60 percentage points. Adding the 120-month BBB spread or the 120-month B spread on top of the current level of real activity and the slope of the term structure (Model III and IV, respectively), results in a significant increase in the short-term (up to 12-months) forecasting ability of the regressions. For example, for Model III and Model IV the R^2s for the 12-months increases by 24 and 13 percentage points with respect to Model II, respectively.

In general, these results suggest that the term spread is informative in forecasting real activity for horizons beyond 2 years, while the corporate spreads are relevant for short-term forecast horizons. However, results based on regression analysis have the problem of relying on only one single realization of the data generating process. In order to have a more robust analysis of the forecasting power of the spreads we employ the population R^2s, which can be thought as the average R^2s that one would get if it were to run the regressions for many different realizations of the data generating process. To this end, we develop a medium-scaled macro-finance model, where corporate and government bonds are priced conditional on a set of state variables. We assume that the data generating process for the state variables is given by a VECM and that the relationship between the state variables is subject to restrictions derived by ruling out arbitrage in the corporate and government bond market. The next section presents our macro-finance model.

3 Model

Our model for pricing the government and corporate term structures of interest rates is based on the exponentially affine framework introduced by Ang and Piazzesi (2003) and implemented in the context of the corporate debt by Amato and Luisi (2006), Mueller (2009) and Wu and Zhang (2008). These types of models express the log of the price (or yields) of a debt instrument as a linear combination of a set of state variables. We explain the movements of the government yields and corporate spreads by three sets of variables: (i) three economic variables, X_t^M: real activity,

g_t, inflation π_t and short term risk-free rate, r_t; (ii) three latent variables with a clear financial interpretation, $l_{1,t}, l_{2,t}$, and $l_{3,t}$; and (iii) one stochastic trend: the long-run inflation expectation, π_t^*. The resulting state vector is composed of seven variables, $X_t = [\pi_t, g_t, r_t, l_{1,t}, l_{2,t}, l_{3,t}, \pi_t^*]$, and is assumed to follow a Gaussian VAR(I) specification:

$$X_t = C + \Phi X_{t-1} + \Sigma\varepsilon_t, \qquad \varepsilon_t \sim \mathcal{N}(0, I). \tag{2}$$

In the remainder of the section, we first outline the standard setting for pricing the government and corporate yield curves. Subsequently, we present the strategy adopted to identify the financial latent variables. The identification of the stochastic trend and the derivation of the state dynamics given in Eq. (2) are presented in section 7.1 of the Appendix.

3.1 Pricing Corporate and Government Debt

3.1.1 Government Yield Curve

The pricing of the government yield curve follows the standard exponentially affine framework (see Ang and Piazzesi (2003) and Duffee (2002)). The short-term interest rate is assumed to be a linear function of the state variables:

$$r_t = \delta_{gov,0} + \delta_{gov,1} X_t, \tag{3}$$

with $\delta_{gov,0} = 0$ and $\delta_{gov,1} = [0, 0, 1, 0, 0, 0, 0]$. The pricing kernel or stochastic discount factor is an exponentially affine function of the short-term interest rate and of the structural shocks appearing in Eq. (2):

$$m_{t+1} = \exp(-r_t - \frac{1}{2}\Lambda_t \Sigma\Sigma' \Lambda_t' - \Lambda_t' \Sigma\varepsilon_t), \tag{4}$$

where the prices of risk Λ_t are linear functions of the state variables:

$$\Lambda_t = \Lambda_0 + \Lambda_1 X_t. \tag{5}$$

The price of a government bond with maturity m, $P_{gov,t}(m)$, is computed by substituting forward the following pricing equation:

$$P_{gov,t}(m) = E_t[m_{t+1} P_{gov,t+1}(m-1)], \tag{6}$$

subject to the initial condition $P_{gov,t}(0) = 1$. The yields are linear functions of the state variables:

$$y_{gov,t}(m) = -P_{gov,t}(m)/m, \tag{7}$$

$$y_{gov,t}(m) = A_{gov,m} + B_{gov,m}X_t, \tag{8}$$

where $A_{gov,m} = -a_{gov,m}/m$ and $B_{gov,m} = -b_{gov,m}/m$ are given by the no-arbitrage difference equations:

$$\begin{aligned} a_{gov,m} &= a_{gov,m-1} + b_{gov,m-1}(C - \Sigma\Lambda_0) + \tfrac{1}{2} b_{gov,m-1}\Sigma\Sigma' b'_{gov,m-1} - \delta_{gov,0}, \\ b_{gov,m} &= b_{gov,m-1}(\Phi - \Sigma\Lambda_1) - \delta_{gov,1}, \end{aligned} \tag{9}$$

with $a_{gov,m} = 0$ and $b_{gov,m} = [0, ..., 0]$.

3.1.2 BBB and B Yield Curves and Spreads

The pricing of the corporate yield curves is performed using the results of Duffie and Singleton (1999). In this setting the spread, $s_{j,t}$, is treated as an exogenous process and the (risk-neutral) expected losses are assumed to be a fraction of the (risk-neutral) expected value of the bond in case of no default ("recovery of market value" assumption). Under these two assumptions, Duffie and Singleton (1999) show that the defaultable debt instrument can be priced using the set-up sketched in section 3.1.1, with the only difference that the risk-free rate, r_t, is replaced by the default-adjusted risk-free rate, $r_t^d = r_t + s_{j,t}$. We define short-term spreads for the BBB and B-rated bonds as linear functions of two latent variables, $l_{2,t}$ and $l_{3,t}$:

$$s_{j,t} = \delta_{j,0} + \delta_{j,1}X_t, \qquad j = BBB, B \tag{10}$$

where $\delta_{BBB,1} = [0, 0, 0, 0, 1, 0, 0]$, $\delta_{B,1} = [0, 0, 0, 0, \delta_{B,1}(5), 1, 0]$. It is important to highlight the economic interpretation of the parameters $\delta_{BBB,0}$, $\delta_{B,0}$ and $\delta_{B,1}(5)$ and of the latent factors $l_{2,t}$ and $l_{3,t}$. First, given that $l_{2,t}$ and $l_{3,t}$ have zero mean, $\delta_{BBB,0}$ and $\delta_{B,0}$ represent, respectively, the instantaneous long-run BBB and B spread, while the parameter $\delta_{B,1}(5)$ is the sensitivity of the instantaneous B spread on variations of the instantaneous BBB spread. Second, given that $l_{2,t}$ drives the movements of both spreads while $l_{3,t}$ is related only to the movements of the B spreads, $l_{2,t}$ is interpreted as a common spread factor while $l_{3,t}$ is labelled as a rating-specific factor.

Given the exponentially affine model for the stochastic discount factor, expressed in Eq. (4), and the definition of the short-term risk-free rate, defined in Eq. (3), the price of BBB and B rated bonds can be expressed as:

$$P_{j,t}(m) = E_t[m_{t+1}P_{j,t+1}(m-1)e^{-s_t^j}], \qquad j = BBB, B. \tag{11}$$

In line with the procedure used for the government bonds, Eq. (11) can be solved by forward substitution, yielding an exponential affine representation for the price of a zero-coupon corporate bonds similar to Eq. (8):

$$y_{j,t}(m) = -P_{j,t}(m)/m, \qquad j = BBB, B, \tag{12}$$

$$\ln P_{j,t}(m) = A_{j,m} + B_{j,m}X_t, \tag{13}$$

where, $A_{j,m} = -a_{j,m}/m$ and $B_{j,m} = -b_{j,m}/m$, are given by the no-arbitrage difference equations:

$$\begin{aligned} a_{j,m} &= a_{j,m-1} + b_{j,m-1}(C - \Sigma\Lambda_0) + \tfrac{1}{2}b_{j,m-1}\Sigma\Sigma' b'_{j,m-1} - (\delta_{gov,0} + \delta_{j,0}), \\ b_{j,m} &= b_{j,m-1}(\Phi - \Sigma\Lambda_1) - (\delta_{gov,1} + \delta_{j,1}), \end{aligned} \tag{14}$$

with $a_{j,m} = 0$, $b_{j,m} = [0, ..., 0]$ and $j = BBB, B$. Credit spreads, which can be calculated by taking the difference between the corporate and government yields, are an affine function of the state variables.

3.2 Identification of the Financial Variables

The identification of the financial variables is performed by imposing a hierarchical structure on the pricing of the government and corporate bonds and by assuming that only three factors -l_1, l_2 and l_3- drive the one-period expected excess returns for these bonds.

The hierarchical structure implies that five, six and seven factors price the government, the BBB-rated and the B-rated bonds, respectively:

$$y_{gov,t}(m) = f_{gov,m}(\pi_t, g_t, r_t, \pi_t^*, l_1), \tag{15}$$

$$y_{BBB,t}(m) = f_{BBB,m}(\pi_t, g_t, r_t, \pi_t^*, l_1, l_2), \tag{16}$$

$$y_{B,t}(m) = f_{B,m}(\pi_t, g_t, r_t, \pi_t^*, l_1, l_2, l_3), \tag{17}$$

where $f_{gov,m}$, $f_{BBB,m}$, and $f_{B,m}$ are affine functions of the factors.[10] In line with several macro-finance studies the government yield curve is priced by only a limited number of factors. We use

[10] The coefficients of these affine functions are defined in Eq. (9) and Eq. (14).

a model set-up comparable to the one of Dewachter and Iania (2010), where the government bonds are priced by three macroeconomic factors, a stochastic trend and a latent factor, l_1, which captures the movements on government yields that are not explained by the other factors. In order to determine the number of factors pricing the BBB yield curve, we note that the first principal component of the BBB spreads captures most of the movements of the spreads present in the data set[11]. Therefore we impose that, besides the factor pricing the government yields, only one additional factor, l_2, is needed to model the BBB yields curve. The number of factors needed to model the B yield curve is determined in a similar fashion. First, since the first principal component of the BBB spreads captures on average 82% of the variation of the B spreads, we impose that l_2 as a common factor for the B spreads. Second, we notice that 83% of the variation in the B spreads which is not explained by the first principal component of the BBB spreads can be captured by a single (second) factor. Therefore, we impose, besides the six factors pricing the BBB curve, an additional factor, l_3, to fully capture the variation of the B spreads. As a consequence, we model the B-rated yield curve by adding the factor l_3 to those pricing BBB-rated bonds.

A second set of assumptions is imposed by analyzing the structure of the realized excess returns on corporate and government bonds. Panel A of Table 4 reports the cumulative variation explained by the first three principal components of the one-year realized excess returns on the 2, 3, 4 and 5-year BBB, B and government bonds. Panel B of the same table reports the R^2s of regressing the first three principal components of the realized excess returns on the (i) data-extracted[12] proxies of l_1, l_2, and l_3 (row 1) and (ii) data-extracted proxies of l_1, l_2, and l_3 and the three observable macro variables (row 2). The table gives us two clear indications on the behavior of the realized excess returns. First, three factors are sufficient to explain 99% of the variation in the realized excess bond returns. Second, the three financial factors are those that, among the state variables, have the most information with respect to the realized excess returns. This is clearly shown by Panel B of Table (4): adding the three macro factors to the regressions results in an increase of R^2's of maximum 2%. As a consequence, we exploit this characteristic of the excess returns and impose that the one-period expected excess returns depend only on

[11] The first principal component of the six BBB-spreads captures 94% of the variation in the series.

[12] The first factor, l_1, is proxied by the return-generating factor extracted by applying the procedure of Cochrane and Piazzesi (2005). The factor l_2 is proxied by the first principal component of the BBB spreads. The factor l_3 is proxied as follows. First we regress the B spreads on l_2 and then we use the first principal component of the residuals of the regressions as a proxy for l_3.

three variables, namely the three financial variables:

$$E_t er_{j,t \to t+1}(m) = f^{er}_{j,m}(l_1, l_2, l_3), \qquad j = gov, BBB, B$$

where $er_{j,t \to t+1}(m)$ is the one period excess returns on a j-rated bond with maturity m and $f^{er}_{j,m}$is an affine function of the three financial factors.

4 Estimation Setting

The model is estimated using standard Bayesian techniques based on informative priors (see Chib and Ergashev (2009) and Dewachter and Iania (2010)). Using Bayes theorem, we write the posterior distribution of the parameters vector θ as:

$$p(\theta \mid Z^T) = \frac{L(\theta \mid Z^T)p(\theta)}{p(Z^T)}, \tag{18}$$

where Z^T denotes the data set, $L(\theta \mid Z^T)$ the likelihood function, $p(\theta)$ the priors, and $p(Z^T)$ the marginal density of the data. We follow Smets and Wouters (2007), among others, and use a two-step procedure to simulate the posterior density of the parameters. In a first step, we find the mode of the posterior distribution of θ using a combination of Newton-Raphson, simplex and simulated annealing optimization procedures. Subsequently, we use a tailored randomized-block MCMC procedure to draw from the posterior density of θ (see Chib and Ramamurthy (2010)). In the remainder of the section, we discuss the likelihood function, the distribution of the priors, and sampling scheme used to draw from the posterior distribution of θ.

4.1 Likelihood Function

The likelihood function is obtained from the prediction error decomposition implied by the measurement equation. Our system can be cast in the following state-space setting, where we make explicit the dependence on the parameter vector θ:

$$X_t = C(\theta) + \Phi(\theta)X_{t-1} + \Sigma(\theta)\varepsilon_t, \quad \varepsilon_t \sim N(0, I), \tag{19}$$

$$Z_t = A(\theta) + B(\theta)X_t + S(\theta)\eta_t, \quad \eta_t \sim N(0, I), \tag{20}$$

where the measurement equation relates the observed data Z_t to the state vector X_t, whose movements are represented by the VAR(I) in Eq. (19).

We use four groups of information variables in the measurement equation. The observed series in Z_t consist of (i) macroeconomic variables ($Z_{macro,t}$), (ii) government yield curve data ($Z_{gov,t}$), (ii) corporate spreads data ($Z_{BBB,t}$ and $Z_{B,t}$), and (iv) survey data ($Z_{survey,t}$):

$$Z_t' = [Z_{macro,t}',\ Z_{gov,t}',\ Z_{spreads,t}',\ Z_{survey,t}'], \tag{21}$$

where

$$Z_{macro,t}' = [\pi_t, g_t, r_t], \qquad Z_{gov,t}' = [y_{gov,t}(m)] \quad m = 3, 12, ..., 60, 120, \tag{22}$$

$$Z_{BBB,t}' = [s_{BBB,t}(m)], \qquad Z_{B,t}' = [s_{B,t}(m)] \quad m = 3, 12, ..., 60, 120, \tag{23}$$

$$Z_{survey,t}' = [F_{\pi,t}^{(12)},\ F_{\pi,t}^{(120)},\ F_{y_{gov}(120),t}^{(3)},\ F_{y_{gov}(120),t}^{(12)}]. \tag{24}$$

The vector and matrices of the system in Eq. (20) are accordingly partitioned in:

$$A'(\theta) = [A_{macro}',\ A_{gov}',\ A_{BBB}',\ A_B',\ A_{survey}'],$$

$$B'(\theta) = [B_{macro}',\ B_{gov}',\ B_{BBB}',\ B_B',\ B_{survey}'],$$

$$S(\theta) = diag(S_{macro}',\ S_{gov}',\ S_{BBB}',\ S_B',\ S_{survey}').$$

A number of observations can be made. First, the macroeconomic variables are observed without errors, which implies that $A_{macro} = 0_{3\times1}$, $B_{macro} = [I_{3\times3}, 0_{3\times4}]$, and $S_{macro} = 0_{3\times1}$. Second, the yields and the spreads are measured with an error. They are related to the state variables through the no-arbitrage equations for the government yields and for the corporate spreads outlined in sections 3.1.1 and 3.1.2. Finally, survey data is used to help identify the stochastic trend for inflation π_t^* and the return-generating factor $l_{3,t}$. The stochastic trend for inflation is identified by linking the model-implied average inflation expectations to the data on 12- and 120-month average inflation forecasts ($F_{\pi,t}^{(12)}$ and $F_{\pi,t}^{(120)}$). The return-generating factor is identified by linking the model-implied expectations of the long-term government yield to the data on 3- and 12-month ahead survey forecasts of the 120-month government yield ($F_{y_{gov}(120),t}^{(3)}$ and $F_{y_{gov}(120),t}^{(12)}$). The loadings for these survey expectations are implied by the transition equation (2). We allow for measurement errors in each of the series: $S_{survey} = [\sigma_{F_{\pi,t}^{(12)}},\ \sigma_{F_{\pi,t}^{(120)}},\ \sigma_{F_{y_{gov}(120)}^{(3)}},\ \sigma_{F_{y_{gov}(120)}^{(12)}}]$.

The log-likelihood function is obtained by exploiting the linearity and normality of the system composed by equations (19) and (20):

$$\ln L(\theta \mid Z^T) = -\frac{T}{2}\ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\left[\ln(\det(V_{Z,t|t})) + (Z_t - Z_{t|t-1})'(V_{Z,t|t})^{-1}(Z_t - Z_{t|t-1})\right] \quad (25)$$

with the prediction error, $Z_t - Z_{t|t-1}$, and its variance, $V_{Z,t|t}$, given by Kalman Filter recursions (see Harvey (1991)).

4.2 Prior Distribution and Sampling Scheme

We set the prior distribution of θ by studying the prior implied term structures of government yields and corporate spreads. Specifically, we formulate a prior which implies that: (i) the government yield curve is upward-sloping; (ii) the spread between government and corporate yields is positive, it increases with maturity and it is higher for lower rated bonds; (iii) the term premium is positive on average. In setting up the priors, we adopt a strategy similar to Chib and Ergashev (2009). Given a specific distributional assumption for the priors, we generate many samples from it. Subsequently, we check if the three conditions are satisfied. If not, we revise the distributional assumption of the priors until we are satisfied with the prior implied shape of the term structure of government yields, corporate spreads and term premia. A detailed description of the prior distribution is given in the Appendix (7.3).

With the prior and likelihood distribution in hand, we find the mode of $p(\theta \mid Z^T)$ by a combination of Newton-Raphson, simplex and simulated annealing optimization procedures. Subsequently, we use a modified version of the tailored randomized-block MCMC procedure of Chib and Ramamurthy (2010) to draw from the posterior density of θ.

4.3 Forecasting Real Activity with the Model

We assess the forecasting ability of the term and corporate spreads by focusing on the theoretical R^2s implied by our model. Given that the population R^2s represent the R^2s implied by the data generating process, they allow to perform a more robust analysis on the forecasting power of the spreads than the sample-based R^2s.

We derive the population coefficients and R^2s along the lines of Ang et al. (2006), but with two important differences: (i) we concentrate on the level of future real activity (Ang et al.

(2006) focus their analysis on growth of real GDP) and (ii) we forecast real activity only by the stationary (detrended) state variables, because π_t^* is not cointegrated with g_t. Below, we highlight how these two differences are reflected in the computation of theoretical coefficients of this simple regression:

$$g_{t+h} = \alpha_h(m) + \beta_h^m s_{gov,t}(m) + e_{t+h}, \tag{26}$$

where the measure of real activity, g_{t+h}, is regressed on the term spread at maturity m, $s_{gov,t}(m) = y_{gov,t}(m) - y_{gov,t}(3)$. Given the equation for the state dynamics, Eq. (2), and the no-arbitrage coefficients relating the state variables to the yields on zero-coupon government and corporate bonds, see Eq. (9), each of the predictive coefficients in Eq. (26) are derived as follows. First, we write down the expression for β_h^m:

$$\beta_h^m = \frac{cov(g_{t+h}, s_{gov,t}(m))}{var(s_{gov,t}(m))}. \tag{27}$$

Then, we derive the expected value of real activity, as implied by the stationary part of the state equation (Eq. (2)):

$$E_t[g_{t+h}] = c + e^g[\Phi^s]^h X_t^s, \tag{28}$$

where c is a constant, X_t^s and Φ^s are the stationary components of X_t and Φ, and e^g is a vector picking the forecast of the real activity from the vector $[\Phi^s]^h X_t^s$. Finally, we solve for the coefficient by using the definitions of variance and covariance:

$$\beta_h^m = \frac{e^g[\Phi^s]^h \Sigma_{X^s}\Sigma'_{X^s}(b^s_{gov,m} - b^s_{gov,1})'}{(b^s_{gov,m} - b^s_{gov,1})\Sigma_{X^s}\Sigma'_{X^s}(b^s_{gov,m} - b^s_{gov,1})'},$$

where $b^s_{gov,m}$ are the elements of $b_{gov,m}$ related to the stationary variables and $\Sigma_{X^s}\Sigma'_{X^s}$ is the unconditional covariance matrix of X^s. Given that the formulas for the R^2s and the coefficients of the multiple regression case are equivalent to those derived by Ang et al. (2006), we refer to that paper for further details.

5 Empirical Results

5.1 Factors

Figure 2 reports the median of the seven factors, together with their 5% error bands. By construction, the three macroeconomic factors, i.e. inflation, real activity and interest rates, are observed without error, while the four latent factors are estimated with relative high precision.[13]

Insert Figure 2 and 3

The return-generating factor shows considerable variation at high and low frequencies. As shown by the top panel of Figure 3, the factor is closely related to the Cochrane and Piazzesi (2005) factor, indicating that it might be a driving force for government bonds risk premia. This intuition is confirmed by analyzing the variance decompositions of the one-year expected excess returns on the two-year and ten-year government bonds, which are reported in the top and bottom panels of Table 5, respectively. Shocks to the return forecasting factor are, after those to the two spreads factors, the third driving force of the low frequency movements of the two-year bond risk premia and the main driving force of the ten year bond risk premia. Intuitively, we find a strong negative correlation between the low frequencies movements of the factor and the real activity, indicating that expected excess returns (risk premia) increase while economic conditions worsen.

Insert Table 5

Turning to the spread factors, we relate $l_{2,t}$ to the level of the BBB spreads and $l_{3,t}$ to the level of the B spreads that are not explained by the common component of the BBB spreads. The level of the BBB spreads is proxied by the first principal component of the BBB spreads (1PC_BBB) and by the average BBB spreads (AVG_BBB). The level of the B spreads unexplained by the level of the BBB spreads is proxied by the first principal component of the B spreads orthogonal to 1PC_BBB (1PC_B_SPR) and by the average spread between the B and BBB yields (AVG_B_SPR). The middle and bottom panels of Figure 3 compare $l_{2,t}$ and $l_{3,t}$ to the data-extracted counterparts. The common corporate factor is almost perfectly correlated with both measures of the level of the BBB spreads, indicating that it acts as a level factor for the spreads on this segment of the corporate bonds market. The rating-specific factor strongly correlates with AVG_B_SPR (0.97), while the correlation with 1PC_B_SPR is milder (0.67). Overall, we can infer that the time series behavior of the series are broadly in line with the data extracted counterparts. The variance decomposition of the 24 and 120-month BBB and B spreads -reported in Table 6- reinforce our interpretation of $l_{2,t}$ as the factor driving of the movements of the BBB and B spreads and of $l_{3,t}$ as the factor driving the movements of the B

[13]It should be noted that we are reporting the error bands of the mean filtered factors.

spreads not explained by $l_{2,t}$.

Insert Table 6

5.2 Model Performance

We evaluate the performance of our model in two dimensions. First, we show that the model provides a good fit for the yields and corporate spreads data. Looking at the fit is fundamental because it gives us a direct measure of the ability of our model to capture the information contained in the corporate spreads. Next, we determine whether the predictability of future real activity implied by our model is in line with the predictability that is present in the data of term and corporate spreads.

5.2.1 Fit of the Yield Curves

The fitting performance of our model is evaluated by focusing on the posterior distributions of a set of statistics of the measurement errors. Table 7 reports the 2.5%, 50% and 97.5% quantiles of the model R^2s and the following statistics of the fitting errors: the mean, the standard deviation, the one-lag autocorrelation and the twelve-lags autocorrelation.

Insert Table 7 and Figure 4

Based on Figure 4 and the statistics of Table 7, we infer that the model offers a very good fit of the three term structures. The average overall R^2 is above 96%, with the average R^2 for the government yields, BBB spreads and B spreads being 99%, 95% and 98%, respectively. The fitting performance of our model is comparable or better than the one of two recent macro-finance models proposed in the literature. First, Mueller (2009) obtains a comparable fit for the government yields and the B spreads (average R^2 around 99% and 98%) but clearly underperforms our model in fitting the BBB spreads, where he obtains levels of R^2s of around 70/80%. Second, Wu and Zhang (2008), who use a small-scaled macro-finance model with only three macroeconomic factors, obtain R^2s of around 70% for the government yield curve and of around 50% for the BBB spreads.

In order to assess the bias of the fit of our model, we analyze the most important statistics of the measurement errors. A unbiased fit should deliver zero mean and uncorrelated measurement errors. Most of the means of the measurement errors are not statistically significantly and are in absolute values below 3 basis points. Despite this, the level and the statistical significance of the autocorrelations suggest that there is some evidence of model misspecification. The average level of the autocorrelation is in absolute values around 52% at one lag and 24% at twelve lags, levels that has been documented in other term structure works (see Duffie and Singleton (1997)).

In order to understand how our model captures the information that the credit spreads and the term spread have about future levels of real activity, in the next section we compare the model-implied theoretical R^2s with the empirical ones.

5.2.2 Matching the R^2s of the Real Activity Regressions

Each panel of Figure 5 reports the 5% error bands (dashed lines) and median of the model-implied theoretical R^2s of the four models analyzed in Section 2.2. The 5% bootstrapped error bands and the point estimates of the correspondent OLS statistics are given by the black and empty triangles, respectively. The model-implied R^2s are the long-run coefficients of determination implied by our macro-finance model, while the OLS R^2s can be thought as one realization of the model-implied statistics. Comparing the two statistics is an implicit validation test for our model since it gives an idea of how likely is that the observed sample R^2s are one manifestation of the model-implied data generating process.

Insert Figure 5

By analyzing Figure 5, the following points can be made. First, most error bands of the empirical R^2s include the theoretical ones, implying that the model delivers levels of predictability that are not at odds with the data. Second, and in line with the findings of Ang et al. (2006), the theoretical R^2s of our affine model provides a precise picture of the forecasting ability of the government yield curve and corporate spreads. This is in contrast width the empirical R^2s, which provide only rough and sometimes imprecise predictions. This is clear by analyzing the width and the pattern of the empirical and theoretical R^2s bands. For forecasting horizons above 3 months the error bands of the theoretical R^2 are much narrower that those of the empirical counterparts. For example, the with of the empirical R^2s error bands range from 63% for 12-month forecasting horizon of Model II to 39% for the 12-month forecasting horizon of Model VI. Furthermore, while the precision and the level of the empirical R^2s are a discontinuous function of the forecasting horizon, the theoretical R^2s smoothly decrease with forecasting horizon.

5.3 Information in the term and corporate spreads

We investigate the information content of the term and corporate spreads on the basis of the theoretical R^2s implied by our macro-finance model. The use of population R^2s is in contrast to most of the studies dealing with the forecasting power of the term spread[14] and new in the context of the corporate spreads.[15]

We compare several predictive regressions, as implied by the macro-finance model, which can be nested in an equation similar to Eq. (29) of Section 2.2:

$$g_{t+h} = \alpha_{h,m} + \lambda_{h,m} g_t + \gamma_{h,m} y_{gov,t}(1) + \beta_{h,m} s_{gov,t}(m) + \delta_{BBB,h,m} s_{BBB,t}(m) + \delta_{B,h,m} s_{B,t}(m) + e_{t+h}, \quad (29)$$

where g_{t+h} is our measure of real activity at time t+h, $y_{gov,t}(1)$ is the one-month short-term risk-free, $s_{gov,t}$ is the term spread at maturity m, $s_{BBB,t}(m)$ is the BBB spread at maturity m and $s_{B,t}(m)$ is the B spread at maturity m. Based on Eq. (29), we first derive the theoretical R^2s of a baseline model in which $\beta_{h,m}$, $\delta_{BBB,h,m}$ and $\delta_{B,h,m}$ are set to zero. Subsequently, we analyze the theoretical R^2s and coefficients of three different models. In Model I we set $\delta_{BBB,h,m}$ and $\delta_{B,h,m}$ to zero , in Model II we set $\beta_{h,m}$ and $\delta_{B,h,m}$ to zero and, finally, in Model III we set $\beta_{h,m}$ and $\delta_{BBB,h,m}$ to zero.

We assess the information content of the term and corporate spreads by jointly analyzing the significance of the coefficients $\beta_{h,m}$ (Model I), $\delta_{BBB,h,m}$ (Model II) and $\delta_{B,h,m}$ (Model III) and the increment in R^2s with respect to the baseline model. Table 8 reports the 2.5%, 50% and 97.5% quantiles of the posterior distribution of the theoretical R^2s of the baseline model while Table 9, 10 and 11 report the same quantiles for the posterior distribution of the theoretical R^2s and coefficients $\beta_{h,m}$, $\delta_{BBB,h,m}$ and $\delta_{B,h,m}$ of Model I, II and III, respectively. We consider four forecasting horizons - 3, 12, 36 and 60-months - and four spreads - 3, 12, 60 and 120-months.

Our main findings can be summarized as follows. First, the information content of the term spread is limited and mainly concentrated at 12- and 60-months forecasting horizons. Second, for forecasting horizons up to 12-months, long-term corporate spreads forecast real activity better than any term spread. Third, corporate spreads relative to intermetiate-risk (BBB-rated)

[14] See, for example, Estrella and Mishkin (1997), Estrella and Mishkin (1998), and Hamilton and Kim (2002) among others.

[15] Two examples of recent studies that investigate the forecasting power of the corporate spreads are Mueller (2009) and Gilchrist et al. (2009). The former bases his analysis on an affine macro-finance model while the latter employs a dynamic factor model.

companies are more informative than those of high-risk ones (B-rated), with spreads of longer maturities that are more informative than shorter ones.

Insert Table 8 to 11

Table 9 highlights that, in spite of the fact that the coefficients $\beta_{h,m}$ of Model I are statistically significant at all maturities and for forecasting horizons of 3-, 12- and 60-months, the increase in R^2s from adding the term spread to the baseline model is small and concentrated at 12- and 60-months forecasting horizons. Comparing our results to recent studies on the forecasting power of the term spread, we confirm the reduction in the forecasting ability of this type of indicator found by Mueller (2009) and Ang et al. (2006). Mueller (2009), using simple OLS analysis, documents the declining importance of the term spread in forecasting GDP growth since the mid-1980's. Ang et al. (2006), using the theoretical R^2s implied by their macro-finance model, find that term spread adds little information on top of the short rate over the period 1952:Q2 to 2001:Q4, with the term spread taken at longer maturities being more in formative that taken at shorter ones. We confirm the results of these two studies and document that, since the beginning of the 1990's, the loss of importance of the term spread is independent of the maturity selected. As pointed out by Mueller (2009), the loss of power of the term spread is in line with a monetary policy regime that has been more concerned in controlling inflation in our sample period. This result is line with the studies of Estrella (2005) and Estrella and Trubin (2006), who stress that the forecasting ability of the term spread hinges on the reaction function of the central bank. If the monetary policy authority concentrates only on controlling inflation the term spread forecasts real activity less accurately.

Turning to corporate spreads, a comparison of Tables 8 to 11 lead us to the main conclusion that, for horizons up to 12-months, corporate spreads – and in particular BBB spreads – outperform term spreads in forecasting real activity. In addition, we find that (i) the R^2s are an increasing function of the maturity of the spreads and that (ii) as the maturity increases, corporate spreads become more informative than term spread in forecasting future real activity.

The posterior distributions of the population coefficients $\delta_{BBB,h,m}$ ($\delta_{B,h,m}$) give us some insight on the economic interpretations of these results. At 3- and 12-months forecasting horizons all coefficients are located on the negative side of the support, meaning that an increase in the corporate spreads is followed by a decrease in the marginal growth of economic activity. This result, combined with the strong increase in R^2s compared to the baseline model, is in line with the financial accelerator mechanism, which suggests that an increase in the external finance premium (corporate spreads) is associated to a decrease in real activity. For longer horizons, the results are mixed with no specific spread that clearly outperforms the others. Controlling for the term spread does alter these results. For example, Figure 6 compares the posterior distribution of the model-implied R^2s of two regressions. In the first regression the future level of real activity is regressed against the 120 BBB spread, the short rate and the current level of real activity. The 5% and 33% error bands of this regression are reported with dark and light shadows, respectively. In the second regression the future level of real activity is regressed against the 120 term spread and the short rate and the current level of real activity. The 5% and 33% error bands of this regression are reported with straight and dashed lines, respectively. Since for horizons below 24-months the posterior distribution of the model-implied R^2s of the first regression is always above that of the second one, Figure 6 stresses the fact that BBB spreads contain different information than the term spread with respect to future real activity. In particular, the corporate spread that is related to the transmission of financial friction to the real economy and the term spread is more related monetary actions.

Insert Figure 6

By analyzing the forecasting power of corporate spreads at different maturities and horizons, three findings stand out. First, spreads on higher graded bonds are more informative than lower graded ones, independently of the maturity and forecasting horizon chosen. This result confirms the findings reported elsewhere in the literature. For example, Gilchrist et al. (2009) show that spreads of intermediate risk corporations deliver higher R^2s than those related to high risk companies, a result that has been confirmed by Mueller (2009). Second, spreads of longer maturities contain more information than those of shorter ones. This result, which is in line with those of Gilchrist et al. (2009) and Mueller (2009), is particularly strong for the forecasting horizons of 12-months. At this forecast horizon the posterior distribution of the population R^2s for the 120M BBB spread (B spread) shifts by 4 (6) percentage points compared to that of the 3M BBB spread (B spread).

6 Conclusion

In this paper we shed some light on the forecasting ability of the term and corporate spreads with respect to future levels of real activity. For this purpose, we build a macro-finance model that consistently prices government and corporate bonds conditional on a set of state variables.

Our results indicate that the term spread seems to have lost most its forecasting power for real activity in the last two decades. The theoretical R^2s implied by the model suggest that adding the term spread on top of the current level of real activity and of the short rate does not result in any significant gain in forecasting power. This result corroborates recent findings of the literature indicating that the relationship between the term spread and future level of real activity is subject to parameter instability and has weakened since early 1990's.

Furthermore, our results advocate the use of the long-term corporate spreads of intermediate-risk profile for forecasting real activity. The theoretical R^2s of the forecasting regressions based on BBB spreads always outperform those based on B spreads, independently of the maturity of the spread and of the forecasting horizon. Furthermore, the information content of the corporate spreads seems to be concentrated on short term horizons (up to 12-months). These findings are in line with the recent empirical work of Gilchrist et al. (2009), who advocate the use of spreads of intermediate-risk companies to forecast real activity, and of Chan-Lau and Ivaschenko (2002), who report that corporate spreads are good forecasters of marginal increase in industrial production for horizons below 18 months.

References

Amato, J. D. and M. Luisi (2006). Macro factors in the term structure of credit spreads. *SSRN eLibrary*.

Ang, A. and M. Piazzesi (2003, May). A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables. *Journal of Monetary Economics 50*(4), 745–787.

Ang, A., M. Piazzesi, and M. Wei (2006). What does the yield curve tell us about gdp growth? *Journal of Econometrics 131*(1-2), 359–403.

Bernanke, B. S. and M. Gertler (1989, March). Agency costs, net worth, and business fluctuations. *American Economic Review 79*(1), 14–31.

Chan-Lau, J. A. and I. V. Ivaschenko (2002, January). The corporate spread curve and industrial production in the united states. (02/8).

Chen, N.-F. (1991). Financial investment opportunities and the macroeconomy. *The Journal of Finance 46*(2), pp. 529–554.

Chib, S. and B. Ergashev (2009). Analysis of multifactor affine yield curve models. *Journal of the American Statistical Association 104*(488), 1324–1337.

Chib, S. and S. Ramamurthy (2010, March). Tailored randomized block mcmc methods with application to dsge models. *Journal of Econometrics 155*(1), 19–38.

Cochrane, J. H. and M. Piazzesi (2005, March). Bond risk premia. *American Economic Review 95*(1), 138–160.

Dewachter, H. and L. Iania (2010). An extended macro-finance model with financial factors. *Journal of Financial and Quantitative Analysis forthcoming*.

Dewachter, H. and M. Lyrio (2006). Macro factors and the term structure of interest rates. *Journal of Money, Credit and Banking 38*(1), 119–140.

Duffee, G. R. (1998, December). The relation between treasury yields and corporate bond yield spreads. *Journal of Finance 53*(6), 2225–2241.

Duffee, G. R. (2002). Term premia and interest rate forecasts in affine models. *The Journal of Finance 57*(1), 405–443.

Duffie, D. and K. J. Singleton (1997, September). An econometric model of the term structure of interest-rate swap yields. *Journal of Finance 52*(4), 1287–1321.

Duffie, D. and K. J. Singleton (1999). Modeling term structures of defaultable bonds. *Review of Financial Studies 12*(4), 687–720.

Estrella, A. (2005, 07). Why does the yield curve predict output and inflation? *Economic Journal 115*(505), 722–744.

Estrella, A. and G. A. Hardouvelis (1991, June). The term structure as a predictor of real economic activity. *Journal of Finance 46*(2), 555–76.

Estrella, A. and F. S. Mishkin (1997). The predictive power of the term structure of interest rates in europe and the united states: Implications for the european central bank. *European Economic Review 41*(7), 1375–1401.

Estrella, A. and F. S. Mishkin (1998, February). Predicting u.s. recessions: Financial variables as leading indicators. *The Review of Economics and Statistics 80*(1), 45–61.

Estrella, A. and M. R. Trubin (2006, July). The yield curve as a leading indicator: Some practical issues. *Current Issues in Economics and Finance 12*(5).

Gertler, M. and C. S. Lown (1999, Autumn). The information in the high-yield bond spread for the business cycle: Evidence and some implications. *Oxford Review of Economic Policy 15*(3), 132–50.

Gilchrist, S., V. Yankov, and E. Zakrajsek (2009). Credit market shocks and economic fluctuations: Evidence from corporate bond and stock markets. *Journal of Monetary Economics 56*(4), 471–493.

Hamilton, J. D. and D. H. Kim (2002, May). A reexamination of the predictability of economic activity using the yield spread. *Journal of Money, Credit and Banking 34*(2), 340–60.

Harvey, A. C. (1991, April). *Forecasting, Structural Time Series Models and the Kalman Filter*. Cambridge University Press.

Kozicki, S. and P. A. Tinsley (2001). Shifting endpoints in the term structure of interest rates. *Journal of Monetary Economics 47*(3), 613–652.

Laurent, R. D. (1988). An interest rate-based indicator of monetary policy. *Economic Perspectives* (Jan), 3–14.

Laurent, R. D. (1989). Testing the "spread". *Economic Perspectives* (Jul), 22–34.

Mueller, P. (2009). Credit spreads and real activity. *Mimeo*.

Politis, D. N. and H. White (2004). Automatic block-length selection for the dependent bootstrap. *Econometric Reviews 23*, 53–70.

Smets, F. and R. Wouters (2007, June). Shocks and frictions in us business cycles: A bayesian dsge approach. *American Economic Review 97*(3), 586–606.

Stock, J. H. and M. W. Watson (1989, May). New indexes of coincident and leading economic indicators. *NBER Macroeconomics Annual 1989, Volume 4*, 351–409.

Stock, J. H. and M. W. Watson (2003, September). Forecasting output and inflation: The role of asset prices. *Journal of Economic Literature 41*(3), 788–829.

Wu, L. and F. X. Zhang (2008). A no-arbitrage analysis of economic determinants of the credit spread term structure. *Management Science 54*, 1160–1175.

Table 1: Real activity measure

Principal component analysis

	1^{st}	2^{nd}	3^{rd}	4^{th}
g_t^U	-0,54	0,03	-0,51	0,67
g_t^{IP}	0,55	0,18	0,37	0,73
g_t^E	0,43	-0,80	-0,41	0,07
g_t^{HELP}	0,46	0,57	-0,66	-0,15
% Variance explained	0,72	0,88	0,98	1

Correlation analysis

	g_t^U	g_t^{IP}	g_t^E	g_t^{HELP}
1^{st}-PC	-0,92	0,94	0,74	0,79

Note: Our measure of real activity is the first principal component of the following normalized series: the unemployment rate (g_t^U) , the year by year growth rate in employment (g_t^E), the year by year growth rate in industrial production (g_t^{IP}) and the Index of Help Wanted Advertising in Newspaper (g_t^{HELP}). The top panel of this table reports the principal components of the four series and the cumulative proportion of variance of the original series explained by the four principal components. The bottom panel reports the correlation between the 1^{st} principal component and the original four series.

Table 2: Summary statistics

	Government Bonds							BBB Spreads						B Spreads						g_t
	1M	3M	12M	36M	60M	84M	120M	3M	12M	36M	60M	84M	120M	3M	12M	36M	60M	84M	120M	
Mean	3,31	3,56	3,84	4,37	4,74	5,03	5,24	1,21	1,14	1,19	1,28	1,34	1,44	3,84	3,77	4,01	4,23	4,30	4,42	0,00
St. Dev	1,74	1,86	1,83	1,60	1,40	1,28	1,17	0,81	0,76	0,77	0,76	0,76	0,74	2,13	2,08	1,99	1,90	1,86	1,85	1,70
Skew.	-0,43	-0,41	-0,42	-0,34	-0,19	-0,07	0,22	2,30	2,32	2,23	2,15	2,15	1,80	1,57	1,54	1,95	2,20	2,37	2,36	-1,59
Kurt.	-1,12	-1,18	-1,10	-0,82	-0,77	-0,70	-0,67	6,02	6,37	5,93	5,77	5,68	4,36	3,83	3,52	5,07	6,15	6,89	7,01	2,70
Auto(1)	0,98	0,99	0,99	0,98	0,98	0,97	0,97	0,97	0,98	0,98	0,98	0,98	0,98	0,97	0,97	0,97	0,97	0,97	0,96	0,99
Auto(3)	0,93	0,94	0,93	0,90	0,89	0,88	0,89	0,85	0,86	0,87	0,87	0,85	0,86	0,80	0,79	0,78	0,78	0,76	0,75	0,93
Auto(12)	0,63	0,64	0,66	0,68	0,68	0,68	0,68	0,49	0,45	0,53	0,54	0,52	0,56	0,45	0,45	0,42	0,42	0,41	0,42	0,66

Correlation Table

	Government Bonds							BBB Spreads						B Spreads						g_t
Maturity	1M	3M	12M	36M	60M	84M	120M	3M	12M	36M	60M	84M	120M	3M	12M	36M	60M	84M	120M	
$y_{y,t}(1)$	1,00	0,99	0,97	0,90	0,82	0,75	0,66	-0,61	-0,66	-0,64	-0,59	-0,59	-0,54	-0,62	-0,64	-0,67	-0,61	-0,56	-0,48	0,79
$y_{y,t}(2)$		1,00	0,99	0,92	0,83	0,76	0,67	-0,60	-0,65	-0,63	-0,58	-0,58	-0,53	-0,62	-0,64	-0,67	-0,61	-0,56	-0,48	0,81
$y_{y,t}(12)$			1,00	0,96	0,89	0,82	0,74	-0,58	-0,64	-0,64	-0,60	-0,60	-0,55	-0,62	-0,65	-0,69	-0,63	-0,58	-0,51	0,82
$y_{y,t}(36)$				1,00	0,98	0,94	0,89	-0,56	-0,60	-0,67	-0,65	-0,66	-0,63	-0,57	-0,60	-0,67	-0,64	-0,61	-0,55	0,79
$y_{y,t}(60)$					1,00	0,99	0,96	-0,53	-0,55	-0,66	-0,66	-0,67	-0,67	-0,51	-0,53	-0,63	-0,62	-0,60	-0,55	0,74
$y_{y,t}(84)$						1,00	0,99	-0,49	-0,51	-0,64	-0,65	-0,66	-0,67	-0,46	-0,48	-0,59	-0,59	-0,58	-0,54	0,69
$y_{y,t}(120)$							1,00	-0,43	-0,45	-0,61	-0,63	-0,64	-0,68	-0,39	-0,41	-0,54	-0,55	-0,55	-0,52	0,63
$s_{BBB,t}(3)$								1,00	0,97	0,92	0,90	0,87	0,82	0,86	0,84	0,84	0,86	0,86	0,84	-0,78
$s_{BBB,t}(12)$									1,00	0,95	0,92	0,91	0,85	0,90	0,89	0,89	0,90	0,89	0,87	-0,80
$s_{BBB,t}(36)$										1,00	0,99	0,98	0,95	0,88	0,87	0,91	0,93	0,93	0,93	-0,81
$s_{BBB,t}(60)$											1,00	0,99	0,98	0,84	0,84	0,89	0,92	0,92	0,93	-0,77
$s_{BBB,t}(84)$												1,00	0,98	0,85	0,85	0,90	0,93	0,94	0,94	-0,76
$s_{BBB,t}(120)$													1,00	0,77	0,77	0,84	0,88	0,89	0,91	-0,72
$s_{B,t}(3)$														1,00	1,00	0,97	0,95	0,93	0,89	-0,73
$s_{B,t}(12)$															1,00	0,98	0,96	0,93	0,89	-0,73
$s_{B,t}(36)$																1,00	0,99	0,97	0,93	-0,77
$s_{B,t}(60)$																	1,00	0,99	0,97	-0,76
$s_{B,t}(84)$																		1,00	0,98	-0,75
$s_{B,t}(120)$																			1	-0,71
g_t																				1

Note: This table reports the summary statistics of the government yields, corporate spreads, the real activity measure and inflation (monthly frequency ranging form 1992:5 to 2010:1 for a total of 213 observations). The top panel reports the mean (Mean), the standard deviation (St. Dev.), the skweness (Skew.), the kurtosis (Kurt.), the autocorrelation at lag one (Auto (1)), three (Auto (3)) and twelfe (Auto (12)). The bottom panel reports the correlation matrix.

Table 3: Predicting real activity

Horizon\Model	I		II		III		IV	
3M	0,90		0,91		0,95		0,95	
	0,85	*0,96*	*0,87*	*0,96*	*0,94*	*0,97*	*0,92*	*0,97*
12M	0,30		0,39		0,63		0,52	
	0,10	*0,76*	*0,18*	*0,76*	*0,50*	*0,89*	*0,38*	*0,83*
24M	0,12		0,27		0,33		0,28	
	0,02	*0,66*	*0,11*	*0,69*	*0,16*	*0,76*	*0,14*	*0,69*
36M	0,07		0,42		0,45		0,48	
	0,01	*0,63*	*0,23*	*0,75*	*0,28*	*0,80*	*0,32*	*0,76*
48M	0,11		0,40		0,40		0,48	
	0,02	*0,60*	*0,25*	*0,71*	*0,26*	*0,71*	*0,32*	*0,74*
60M	0,20		0,30		0,31		0,35	
	0,03	*0,70*	*0,15*	*0,70*	*0,17*	*0,73*	*0,19*	*0,74*

Note: Panel A and panel B report the R^2s of seven models based on the following regression:

$$g_{t+h} = \alpha_h(120) + \lambda_h g_t + \gamma_h y_{y,t}(3) + \beta_h s_{y,t} + \delta_h s_{j,t}(120) + e_{t+h}, \tag{30}$$

where g_{t+h} is the measure of the real activity at time $t+h$; $y_{y,t}(3)$ is the 3-month government yield; $s_{y,t} = y_{y,t}(120) - y_{y,t}(3)$ is the slope of the government yield curve; $s_{j,t}(120)$, $j = BBB, B$, is the spread between the $j-$rated corporate bond yields with maturity 120M and the correspondent government yields. In Model I we regress g_{t+h} on g_t, and therefore we set $\gamma_h = \beta_h = \delta_h = 0$; in Model II we regress g_{t+h} on g_t and $s_{y,t}$, i.e. we set $\gamma_h = \delta_h = 0$; in Model III (Model IV) we regress g_{t+h} on g_t, $s_{y,t}$ and $s_{BBB,t}(120)$ ($s_{B,t}(120)$), i.e. we set $\gamma_h = 0$. In Models V, VI and VII, we add $y_{y,t}(3)$ to the regressors of Models II, III and IV, respectively. The 95% error bands (reported in italics) are computed using block bootstrap, where the size of the block is chosen using the procedure proposed by Politis and White (2004).

Table 4: Realized excess returns: PCA and regression analysis

Panel A: Principal comp. analysis

Princ. Comp.	1st	2nd	3rd
Cum. Var. Expl.	75%	98%	99%

Panel B: Regression analysis

Princ. Comp.	1st	2nd	3rd
$l_{1,t}, l_{2,t}, l_{3,t}$	58%	22%	48%
$l_{1,t}, l_{2,t}, l_{3,t}, \pi_t, g_t, r_t$	59%	24%	49%

Note: Panel A reports the cumulative variance of realized one-year excess returns on 24, 36, 48 and 60-month government, BBB and B bond explained by the first three principal components of the series. Panel B reports the R^2s of regressing the first three principal components of the one-year realized excess returns on 24, 36, 48 and 60-month government, BBB and B bond on the data extracted factors $l_{1,t}, l_{2,t}$ and $l_{3,t}$ (first row) and on the the data extracted factors $l_{1,t}, l_{2,t}$ and $l_{3,t}$ and the macro-factors of the model (second row).

Table 5: Variance decomposition of the risk premia

	24M Gov Bond						
Horizon/Shocks	σ_{π}	σ_{g}	σ_{r}	σ_{l_1}	σ_{l_2}	σ_{l_3}	σ_{π^*}
1M	0,00	0,00	0,00	0,01	0,99	0,00	0,00
4M	0,00	0,00	0,00	0,12	0,86	0,01	0,00
12M	0,00	0,00	0,00	0,25	0,56	0,19	0,00
60M	0,00	0,00	0,00	0,21	0,55	0,24	0,00
120M	0,00	0,00	0,00	0,22	0,53	0,24	0,00

	120M Gov Bond						
Horizon/Shocks	σ_{π}	σ_{g}	σ_{r}	σ_{l_1}	σ_{l_2}	σ_{l_3}	σ_{π^*}
1M	0,00	0,03	0,01	0,76	0,01	0,19	0,00
4M	0,01	0,03	0,02	0,72	0,02	0,19	0,00
12M	0,01	0,04	0,03	0,69	0,04	0,18	0,00
60M	0,01	0,03	0,03	0,68	0,06	0,18	0,00
120M	0,01	0,03	0,03	0,66	0,08	0,19	0,00

Note: This table reports the forecasting error variance decomposition (computed at the mode of the posterior distribution of the parameters) of the 12-month government bond premia of 24 and 120-month maturity bonds. Identification of the shocks is obtained by a lower triangular structure on the matrixes D^{MM} and D^{ll} of Eq. (37): σ_{π}.is a supply shock; σ_g is a demand shock; σ_r is a policy rate shock; σ_{l_1} is a shock to the return-generating factor; σ_{l_2} is a shock to the common corporate factor; σ_{l_3} is a shock to the rating-specific factor; σ_{π^*} is a shock to the stochastic trend of inflation.

Table 6: Variance decomposition of selected BBB and B spreads

24M BBB Spreads

Horizon/Shocks	σ_π	σ_g	σ_r	σ_{l_1}	σ_{l_2}	σ_{l_3}	σ_{π^*}
1M	0,00	0,00	0,00	0,01	0,99	0,00	0,00
4M	0,00	0,00	0,00	0,02	0,97	0,00	0,00
12M	0,00	0,00	0,01	0,11	0,86	0,02	0,00
60M	0,00	0,00	0,01	0,18	0,56	0,24	0,00
120M	0,00	0,00	0,01	0,20	0,54	0,24	0,00

120M BBB Spreads

Horizon/Shocks	σ_π	σ_g	σ_r	σ_{l_1}	σ_{l_2}	σ_{l_3}	σ_{π^*}
1M	0,01	0,00	0,05	0,09	0,85	0,00	0,00
4M	0,01	0,00	0,05	0,12	0,80	0,01	0,00
12M	0,01	0,00	0,06	0,19	0,67	0,07	0,00
60M	0,00	0,00	0,06	0,18	0,51	0,25	0,00
120M	0,00	0,00	0,04	0,21	0,47	0,27	0,00

24M B Spreads

Horizon/Shocks	σ_π	σ_g	σ_r	σ_{l_1}	σ_{l_2}	σ_{l_3}	σ_{π^*}
1M	0,00	0,00	0,00	0,08	0,45	0,46	0,00
4M	0,00	0,00	0,01	0,07	0,54	0,38	0,00
12M	0,00	0,00	0,01	0,08	0,68	0,22	0,00
60M	0,00	0,00	0,03	0,16	0,56	0,25	0,00
120M	0,00	0,00	0,02	0,19	0,54	0,24	0,00

120M B Spreads

Horizon/Shocks	σ_π	σ_g	σ_r	σ_{l_1}	σ_{l_2}	σ_{l_3}	σ_{π^*}
1M	0,00	0,01	0,05	0,24	0,50	0,20	0,00
4M	0,00	0,00	0,05	0,21	0,58	0,15	0,00
12M	0,00	0,00	0,07	0,19	0,66	0,07	0,00
60M	0,00	0,00	0,10	0,17	0,52	0,20	0,00
120M	0,00	0,00	0,07	0,21	0,49	0,22	0,00

Note: This table reports the forecasting error variance decomposition (computed at the mode of the posterior distribution of the parameters) of 24 and 120-month maturity bonds.BBB and B spreads. Identification of the shocks is obtained by a lower triangular structure on the matrixes D^{MM} and D^{ll} of Eq. (37): σ_π.is a supply shock; σ_g is a demand shock; σ_r is a policy rate shock; σ_{l_1} is a shock to the return-generating factor; σ_{l_2} is a shock to the common corporate factor; σ_{l_3} is a shock to the rating-specific factor; σ_{π^*} is a shock to the stochastic trend of inflation.

Table 7: Fitting errors: posterior distributions of selected statistics

Panel A: Government yields

Maturity	R^2			$100 \times \mu$			$100 \times \sigma$			ρ_1			ρ_{12}		
	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,98	0,98	0,98	0,10	0,11	0,12	0,23	0,23	0,23	0,46	0,47	0,49	0,43	0,44	0,45
12M	0,97	0,97	0,97	-0,06	-0,03	-0,01	0,30	0,31	0,31	0,49	0,51	0,53	0,21	0,24	0,26
36M	0,98	0,99	0,99	-0,04	-0,02	0,00	0,18	0,19	0,20	0,46	0,48	0,50	-0,02	0,01	0,05
60M	1,00	1,00	1,00	0,00	0,00	0,01	0,05	0,06	0,07	0,35	0,39	0,43	0,00	0,04	0,08
84M	1,00	1,00	1,00	-0,01	0,00	0,00	0,06	0,07	0,08	0,36	0,39	0,42	-0,15	-0,13	-0,10
120M	0,99	0,99	0,99	-0,02	0,00	0,02	0,12	0,13	0,14	0,62	0,66	0,68	0,33	0,37	0,42

Panel B: BBB spreads

Maturity	R^2			$100 \times \mu$			$100 \times \sigma$			ρ_1			ρ_{12}		
	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,87	0,87	0,87	-0,01	0,02	0,05	0,29	0,29	0,30	0,67	0,69	0,70	0,50	0,52	0,55
12M	0,93	0,93	0,93	-0,02	-0,01	0,01	0,20	0,20	0,21	0,62	0,66	0,68	0,48	0,52	0,54
36M	0,98	0,98	0,98	-0,01	0,00	0,01	0,10	0,10	0,11	0,37	0,39	0,42	-0,09	-0,05	-0,01
60M	0,99	0,99	0,99	0,00	0,00	0,01	0,07	0,08	0,09	0,36	0,40	0,44	0,04	0,09	0,14
84M	0,97	0,98	0,98	-0,01	0,00	0,01	0,11	0,12	0,13	0,56	0,60	0,62	0,41	0,43	0,45
120M	0,95	0,95	0,96	-0,02	0,00	0,03	0,15	0,16	0,16	0,57	0,59	0,61	0,29	0,32	0,35

Panel C: B spreads

Maturity	R^2			$100 \times \mu$			$100 \times \sigma$			ρ_1			ρ_{12}		
	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,95	0,95	0,96	-0,03	0,02	0,07	0,45	0,46	0,48	0,59	0,61	0,63	0,26	0,31	0,37
12M	0,96	0,96	0,97	-0,06	-0,03	0,01	0,39	0,40	0,42	0,52	0,54	0,56	0,23	0,28	0,33
36M	0,99	0,99	0,99	-0,04	-0,02	0,00	0,20	0,21	0,22	0,65	0,68	0,70	0,22	0,27	0,32
60M	1,00	1,00	1,00	0,00	0,01	0,02	0,07	0,08	0,10	0,36	0,39	0,42	0,03	0,08	0,13
84M	0,99	0,99	0,99	-0,05	-0,03	-0,01	0,18	0,19	0,20	0,54	0,57	0,59	0,15	0,17	0,20
120M	0,96	0,97	0,97	-0,05	0,00	0,05	0,33	0,34	0,35	0,39	0,41	0,44	0,14	0,18	0,22

Note: This table reports the 5%, 50% and 95% quantiles of the model R^2s and the following statistics of the fitting errors: the mean (μ), the standard deviation (σ), the one-lag autocorrelation (ρ_1) and the twelve-lags autocorrelation (ρ_{12})

Table 8: Information in the short rate and real activity

h	2.5%	16.7%	50%	83.3%	97.5%
3M	0,88	0,90	0,91	0,93	0,95
12M	0,56	0,61	0,65	0,71	0,77
36M	0,37	0,43	0,48	0,55	0,63
60M	0,11	0,16	0,20	0,26	0,34

Note: This table reports the reports the .25, .167, .50, .833 and .975 error bands of the posterior distribution of the theoretical R^2s based on the following regression:

$$g_{t+h} = \alpha_h + \lambda_h g_t + \gamma_h y_{gov,t}(1) + e_{t+h}, \tag{31}$$

where g_t is the current level of real activity and $y_{gov,t}(1)$ is the short rate.

Table 9: Information in the term spread

Panel A: information in the term spread (R-squared)

For. Hor.		3M			12M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,89	0,92	0,95	0,59	0,68	0,79
12M	0,89	0,92	0,95	0,59	0,68	0,80
60M	0,89	0,92	0,95	0,60	0,68	0,80
120M	0,89	0,92	0,95	0,60	0,68	0,80

For. Hor.		36M			60M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,37	0,48	0,64	0,16	0,25	0,38
12M	0,37	0,48	0,64	0,16	0,25	0,38
60M	0,37	0,48	0,64	0,16	0,25	0,38
120M	0,37	0,48	0,64	0,16	0,25	0,38

Panel B: information in the term spread (Coefficients)

For. Hor.		3M			12M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	1,45	2,50	3,55	4,48	7,16	10,40
12M	0,29	0,46	0,62	0,78	1,22	1,75
60M	0,10	0,15	0,20	0,25	0,38	0,54
120M	0,11	0,16	0,21	0,27	0,41	0,58

For. Hor.		36M			60M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	-1,78	1,21	4,86	-13,65	-9,51	-6,47
12M	-0,27	0,22	0,80	-2,23	-1,56	-1,06
60M	-0,08	0,07	0,25	-0,68	-0,49	-0,33
120M	-0,09	0,07	0,27	-0,73	-0,52	-0,35

Note: Panel A and B report the posterior distribution of the theoretical R^2s and the coefficients $\delta_h^{gov}(m)$ based on the following regression:

$$g_{t+h} = \alpha_h + \lambda_h g_t + \gamma_h y_{gov,t}(1) + \delta_h^{gov}(m) s_{gov,t}(m) + e_{t+h}, \tag{32}$$

where g_t is the current level of real activity, $y_{gov,t}(1)$ is the short rate, and $s_{gov,t}(m)$ is the term spread, $s_{gov,t}(m) = y_{gov,t}(m) - y_{gov,t}(1)$, for m = 3, 12, 60 and 120. For each panel, the four sub-panel reports the .025, .50, and .975 error bands for the 3, 12, 36 and 60-month forecasting horizons (from left to right and from top to bottom, respectively).

Table 10: Information in the BBB spreads

Panel B: information in the BBB spread (R-squared)

For. Hor.		3M			12M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,91	0,93	0,96	0,67	0,74	0,83
12M	0,91	0,93	0,96	0,68	0,75	0,84
60M	0,92	0,94	0,96	0,71	0,77	0,86
120M	0,92	0,94	0,96	0,71	0,78	0,86

For. Hor.		36M			60M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,37	0,48	0,63	0,12	0,21	0,36
12M	0,37	0,48	0,63	0,13	0,22	0,37
60M	0,37	0,48	0,63	0,15	0,24	0,39
120M	0,37	0,48	0,64	0,15	0,24	0,39

Panel C: information in the BBB spread (Coefficients)

For. Hor.		3M			12M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	-0,70	-0,61	-0,52	-1,52	-1,25	-0,99
12M	-0,71	-0,63	-0,55	-1,58	-1,32	-1,07
60M	-0,70	-0,64	-0,57	-1,58	-1,37	-1,21
120M	-0,66	-0,60	-0,53	-1,49	-1,30	-1,15

For. Hor.		36M			60M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	-0,37	-0,09	0,28	0,16	0,47	0,88
12M	-0,40	-0,11	0,27	0,24	0,56	1,00
60M	-0,47	-0,14	0,22	0,52	0,78	1,19
120M	-0,46	-0,14	0,21	0,51	0,76	1,15

Note: Panel A and B report the posterior distribution of the theoretical R^2s and $\delta_h^{BBB}(m)$ coefficients based on the following regression:

$$g_{t+h} = \alpha_h + \lambda_h g_t + \gamma_h y_{gov,t}(1) + \delta_h^{BBB}(m) s_{BBB,t}(m) + e_{t+h}, \quad (33)$$

where g_t is the current level of real activity, $y_{gov,t}(1)$ is the short rate, and $s_{BBB,t}(m)$ is the BBB spread, $s_{bbb,t}(m) = y_{bbb,t}(m) - y_{gov,t}(m)$ for m = 3, 12, 60 and 120. For each panel, the four sub-panel reports the .025, .50 and .975 error bands for the 3, 12, 36 and 60-month forecasting horizons (from left to right and from top to bottom, respectively).

Table 11: Information in the B spreads

Panel B: information in the B spread (R-squared)

For. Hor.		3M			12M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,89	0,92	0,95	0,57	0,66	0,78
12M	0,89	0,92	0,95	0,57	0,66	0,78
60M	0,90	0,93	0,96	0,61	0,69	0,80
120M	0,91	0,93	0,96	0,64	0,72	0,82

For. Hor.		36M			60M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,38	0,49	0,65	0,11	0,20	0,34
12M	0,38	0,49	0,65	0,11	0,20	0,34
60M	0,38	0,48	0,64	0,11	0,20	0,35
120M	0,37	0,48	0,64	0,12	0,21	0,36

Panel C: information in the B spread (Coefficients)

For. Hor.		3M			12M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	-0,15	-0,10	-0,06	-0,18	-0,09	0,00
12M	-0,16	-0,11	-0,07	-0,21	-0,12	-0,02
60M	-0,26	-0,20	-0,14	-0,44	-0,31	-0,18
120M	-0,30	-0,24	-0,19	-0,56	-0,42	-0,28

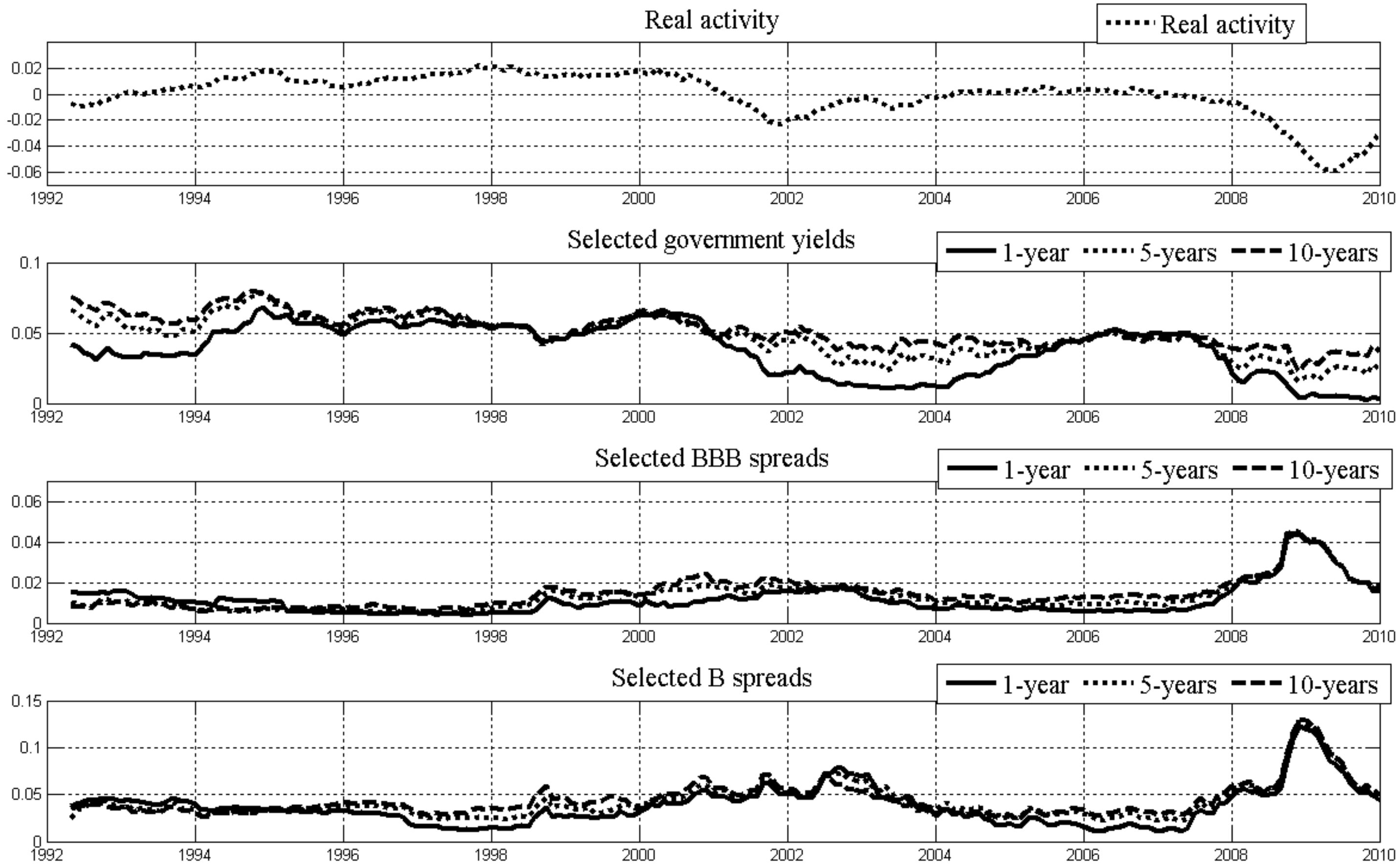
For. Hor.		36M			60M	
m \ e.b.	2.5%	50%	97.5%	2.5%	50%	97.5%
3M	0,04	0,12	0,24	-0,13	-0,05	0,02
12M	0,03	0,13	0,24	-0,11	-0,03	0,04
60M	0,00	0,11	0,25	0,03	0,11	0,24
120M	-0,05	0,08	0,23	0,09	0,20	0,36

Note: Panel A and B report the posterior distribution of the theoretical R^2s and $\delta_h^B(m)$ coefficients based on the following regression:

$$g_{t+h} = \alpha_h + \lambda_h g_t + \gamma_h y_{gov,t}(1) + \delta_h^B(m) s_{B,t}(m) + e_{t+h}, \tag{34}$$

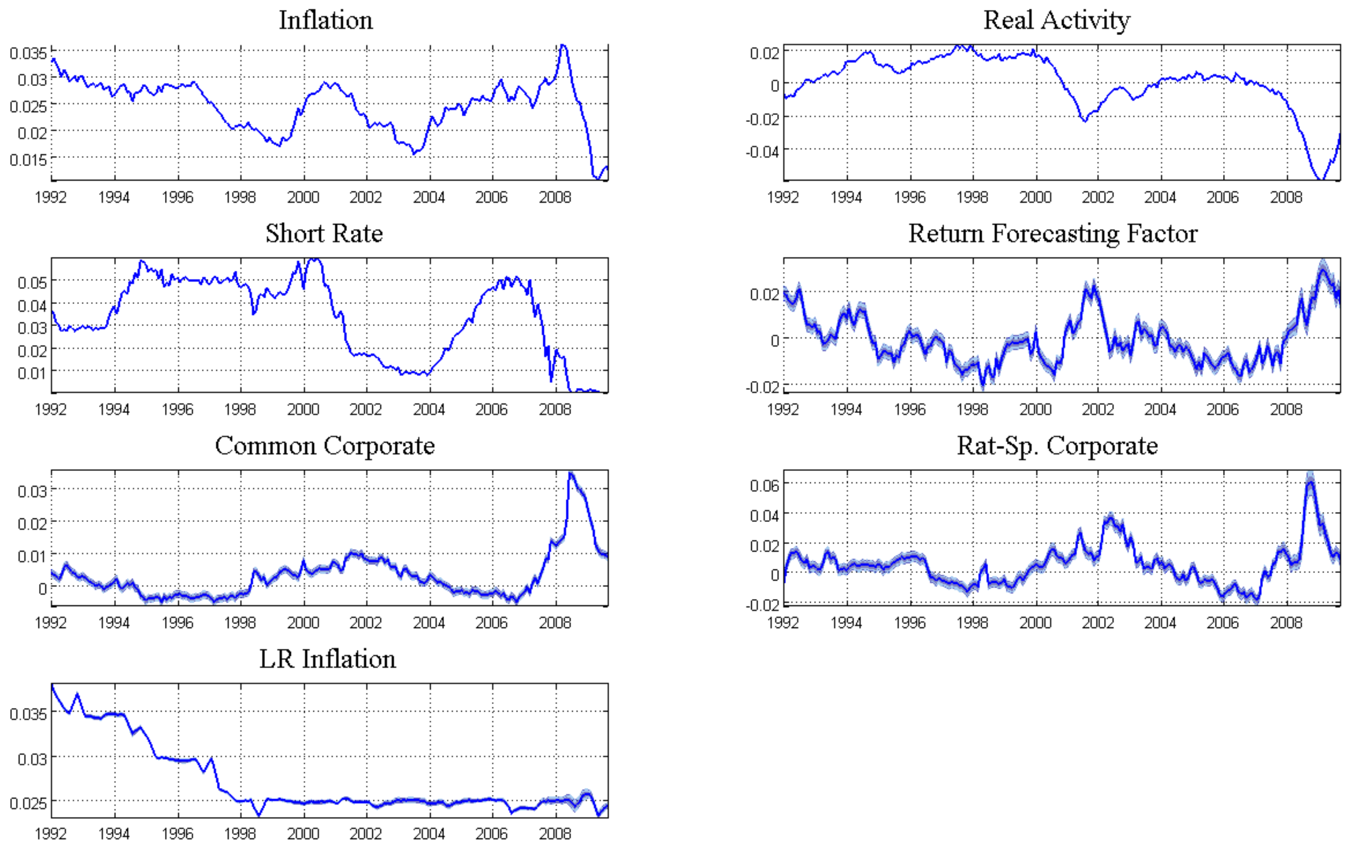
where g_t is the current level of real activity, $y_{gov,t}(1)$ is the short rate, and $s_{B,t}(m)$ is the B spread, $s_{B,t}(m) = y_{B,t}(m) - y_{gov,t}(m)$ for m = 3, 12, 60 and 120. For each panel, the four sub-panel reports the .025, .50 and .975 error bands for the 3, 12, 36 and 60-month forecasting horizons (from left to right and from top to bottom, respectively).

Figure 1: Macro variable, selected government yields and selected corporate spreads



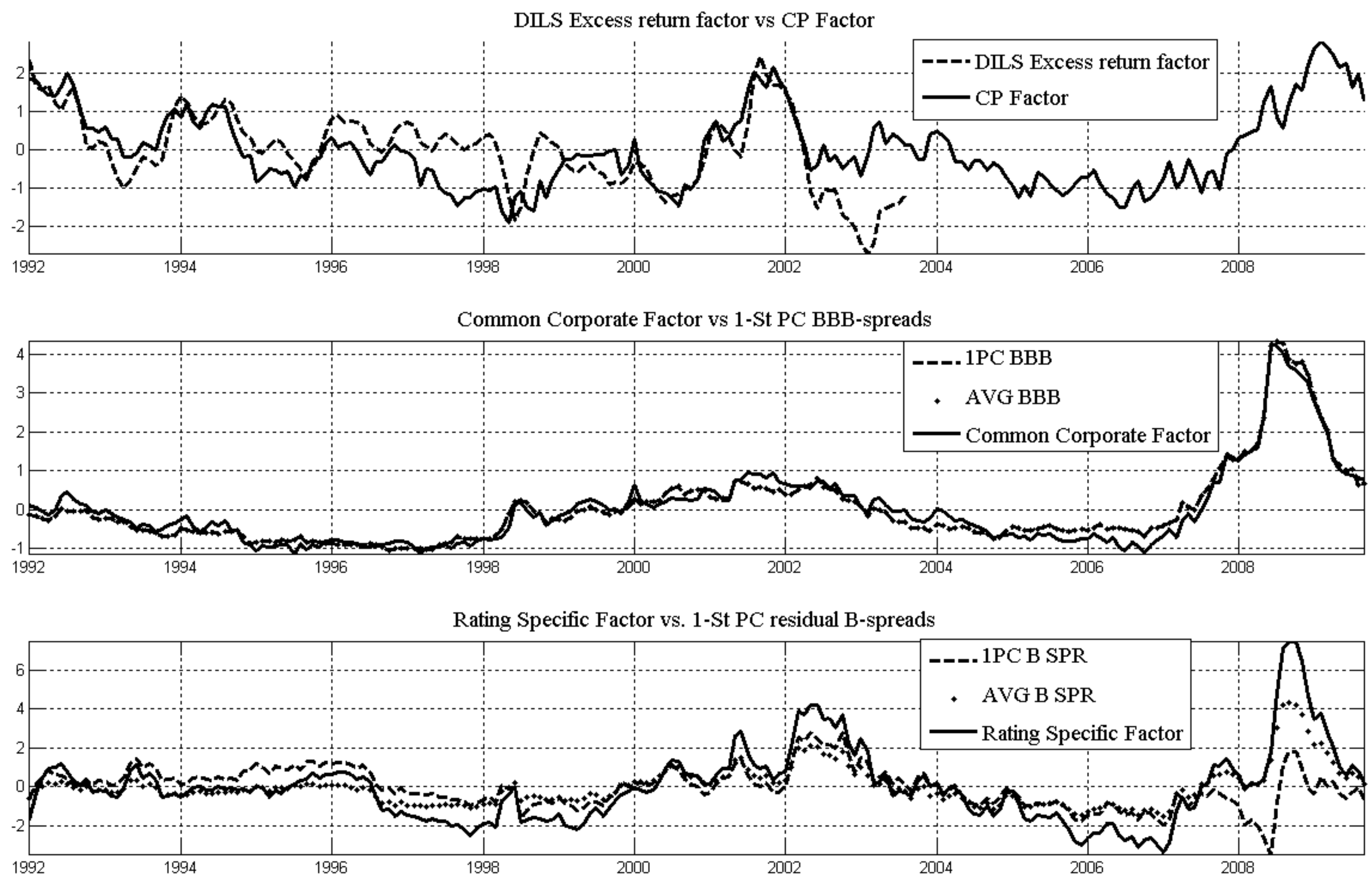
Note: The top panel reports the series our measure of real activity. The second panel report the series of the 12, 60 and 120-months zero coupon government yields. The last two panels depict the 12, 60 and 120-months BBB and B spreads, respectively.

Figure 2: Filtered factors



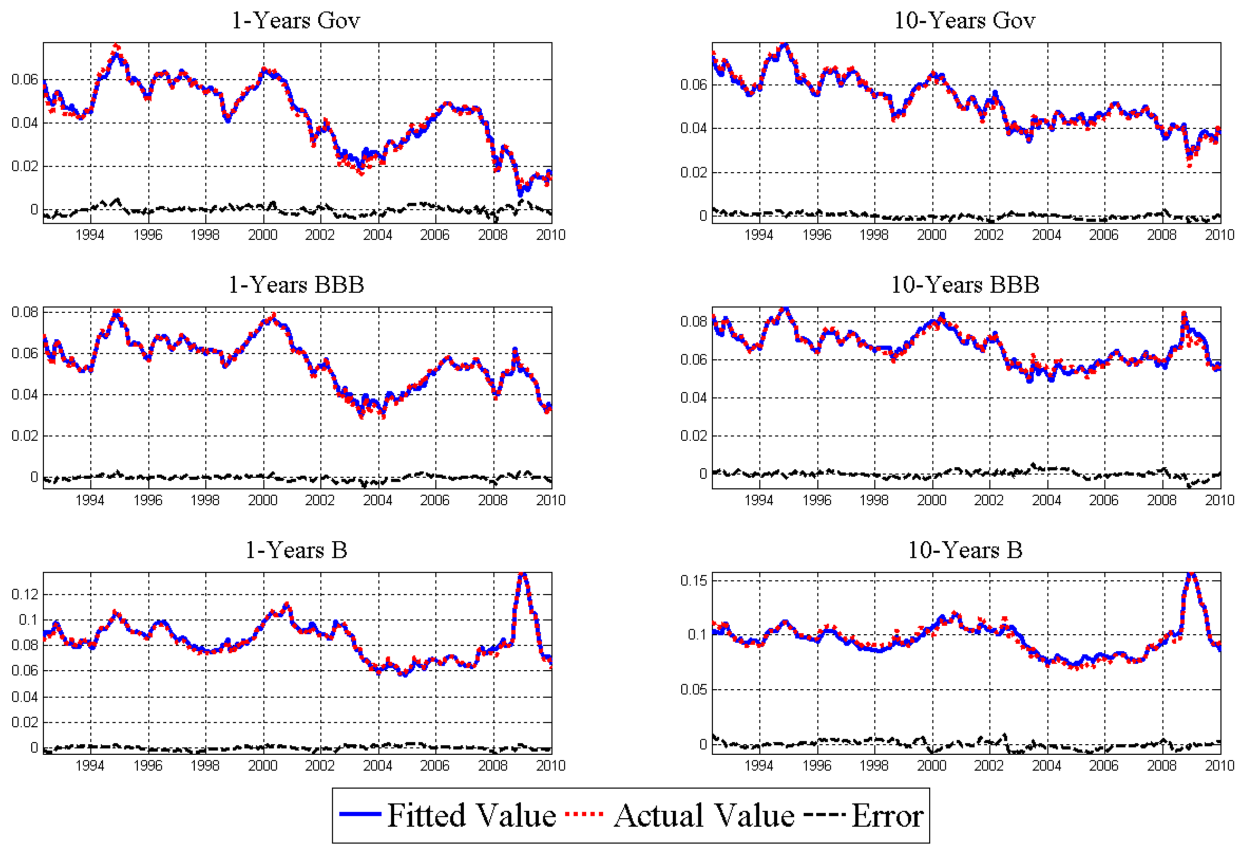
Note: This figure reports the median and 95% error bands of the posterior distribution of the seven filtered factors.

Figure 3: Filtered financial factors and data-extracted counterparts



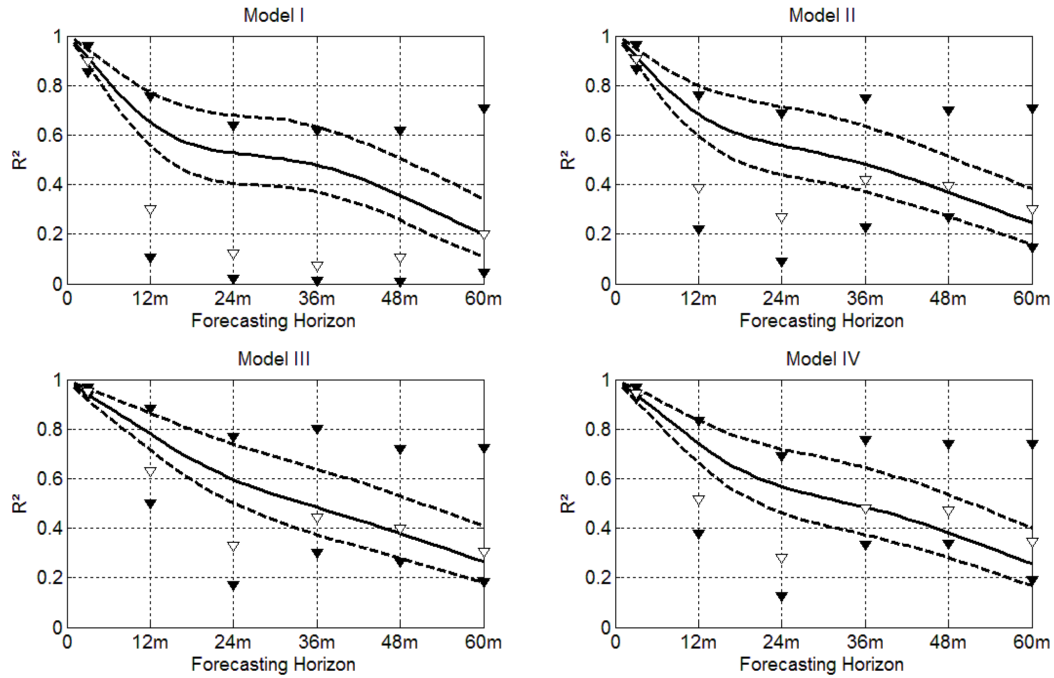
Note: The top panel of the figure reports extracted return-generating factor (DILS factor) together with the Cochrane and Piazzesi (2005) factor (CP factor, dashed line). The DILS factor is evaluated at the mode of the posterior distribution while the CP factor is computed by using the Cochrane and Piazzesi (2005) procedure and the dataset available at the American Economic Review website. The middle panel depicts the filtered common corporate factor (evaluated at the mode of the posterior distribution) together with the first principal component of the BBB spreads (1PC BBB, dashed lines) and the average BBB spreads (AVG BBB, dotted lines). The bottom panel reports the filtered rating-specific factor (evaluated at the mode of the posterior distribution) together with the first principal component of the B spreads orthogonal to 1PC BBB (1PC B SPR, dashed lines) and the average spread between the B and BBB yields (AVG B SPR, dotted lines).

FIGURE 4: Fit of selected yields and spreads



Note: This figure reports the fitted value (continuous line), the actual value (dotted line) and the fitting errors (dashed lines) of the 1 and 10-year government yields (top two panels), the 1 and 10-year BBB yields (middle two panels) and of the 1 and 10 B yields (bottom two panels). The series run from 1992:5–2010:1.

FIGURE 5: Theoretical vs. empirical R-Squared

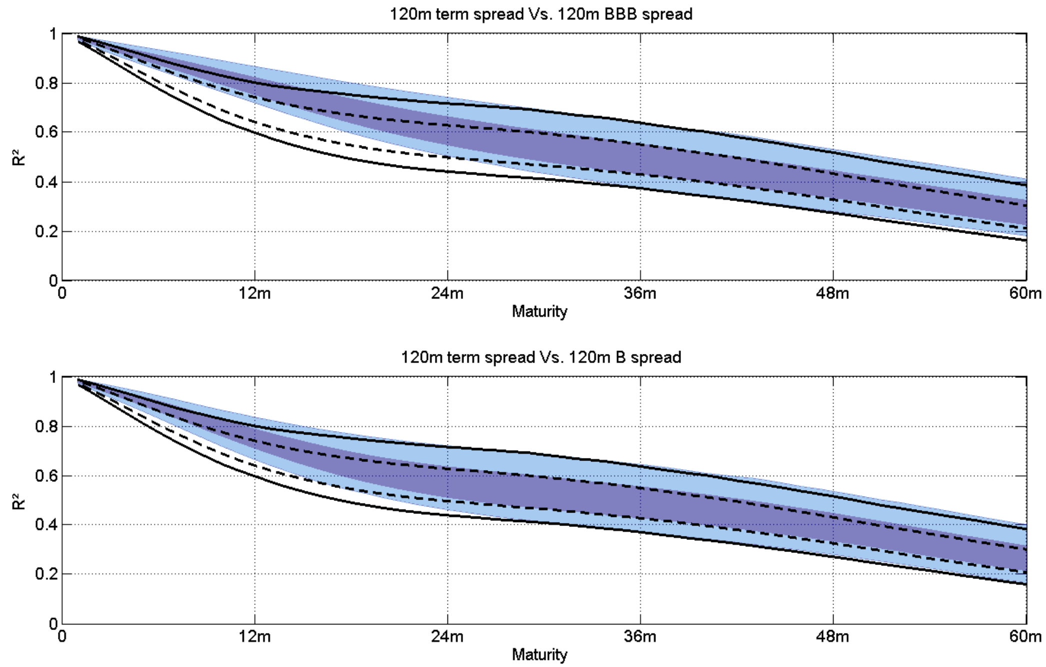


Note: The figure reports the posterior distribution of the theoretical R^2s based on the following regression:

$$g_{t+h} = \alpha_h + \lambda_h g_t + \gamma_h y_{gov,t}(1) + \delta_h s_{j,t}(m) + e_{t+h}, \tag{35}$$

where g_t is the current level of real activity, $y_{gov,t}(1)$ is the short rate, and $s_{j,t}(m)$ is either the 120-months term spread, the 120-months BBB spread or 120-months B spread. In the top three panels we use as control variables the current level of real activity and the 10-years term spread, the 120-months BBB and B spreads (from left to right). In the top three panels we use as control variables the current level of real activity, the short rate and the 10-years term spread, the 120-months BBB and B spreads (from left to right) Each panel reports the median (dashed lines), the 67% and the 95% error bands (darker and lighter shadows, respectively) of the model-implied theoretical R^2s of the regressions. The 95% bootstrapped error bands of the R^2s of the empirical OLS are superimposed as black triangles.

FIGURE 6: 120-months BBB spreads vs. 120-months term spread



Note: The top panel reports the error bands of the model-implied theoretical R^2s of two regressions. In the first regression the future level of real activity is regressed against the 120 BBB spread, the short rate and the current level of real activity. The 95% and 67% error bands of this regression are reported by the dark and light shadows, respectively. In the second regression the future level of real activity is regressed against the 120 term spread and the short rate and the current level of real activity. The 95% and 67% error bands of this regression are reported by the straight and dashed lines, respectively. The bottom panel reports the error bands of the model-implied theoretical R^2s of similar regressions, the only difference being that the dark and light shadows represent 95% and 67% error bands of regressing the future level of real activity against the 120 B spread, the short rate and the current level of real activity.

7 Appendix

7.1 Identification of the stochastic trend and resulting state dynamics

7.1.1 Stochastic Endpoint for Inflation

Following Kozicki and Tinsley (2001) and Dewachter and Lyrio (2006) we model the persistence in the government yield curve by allowing for a stochastic trend for inflation. The stochastic endpoint π_t^* is introduced as the long-run expected value of the observed macroeconomic variables:

$$\lim_{s\to\infty} E_t X_{t+s}^M = \lim_{s\to\infty} E_t \begin{bmatrix} \pi_t \\ g_t \\ i_t \end{bmatrix} = \begin{bmatrix} \pi_t^* \\ 0 \\ \rho + \pi_t^* \end{bmatrix}. \tag{36}$$

The two main implications of Eq. (36) are that the long-run expected value of inflation converges to π_t^*, and that, in line with the Fisher hypothesis, the long-run expected value of i_t converges to $\rho + \pi_t^*$, where ρ is the long-run expected value of the short term interest rate.

7.1.2 Resulting state dynamics

The interaction between the state variables is represented by a VAR(I) subject to the condition that: (i) the stochastic trend π_t^* is an exogenous and independent process which drives the variations in the long-run expectations of the macroeconomic variables, as summarized by Eq. (36); (ii) the long-run expected value of the stationary latent factors is zero, i.e. $\lim_{s\to\infty} E_t l_{t+s} = [0,0,0]'$; (iii) the macroeconomic state, X_t^M is stationary and interact with the stationary latent factors, l_t. These conditions can be expressed as a set of restrictions on the matrixes C, Φ and Σ of the VAR(I) system of Eq. (2). Specifically, we can rewrite the state dynamics as:

$$\begin{bmatrix} X_t^M \\ l_t \\ \pi_t^* \end{bmatrix} = \begin{bmatrix} C_{[3,1]}^M \\ C_{[3,1]}^l \\ 0_{[1,1]} \end{bmatrix} + \begin{bmatrix} \Phi_{[3,3]}^{MM} & \Phi_{[3,3]}^{Ml} & 0_{[3,1]} \\ \Phi_{[3,3]}^{lM} & \Phi_{[3,3]}^{ll} & 0_{[3,1]} \\ 0_{[1,3]} & 0_{[1,3]} & I_{[1,1]} \end{bmatrix} \begin{bmatrix} X_{t-1}^M \\ l_{t-1} \\ \pi_{t-1}^* \end{bmatrix}$$
$$+ \begin{bmatrix} I_{[3,3]} - \Phi_{[3,3]}^{MM} & -\Phi_{[3,3]}^{Ml} & 0_{[3,1]} \\ -\Phi_{[3,3]}^{lM} & I_{[3,3]} - \Phi_{[3,3]}^{ll} & 0_{[3,1]} \\ 0_{[1,3]} & 0_{[1,3]} & 0_{[1,1]} \end{bmatrix} \begin{bmatrix} T_{[3,1]}^D \\ 0_{[3,1]} \\ 0_{[1,1]} \end{bmatrix} \pi_t^* + \begin{bmatrix} D_{[3,3]}^{MM} & 0_{[3,3]} & 0_{[3,1]} \\ D_{[3,3]}^{lM} & D_{[3,3]}^{ll} & 0_{[3,1]} \\ 0_{[1,3]} & 0_{[1,3]} & S_{[1,1]}^{\pi^*\pi^*} \end{bmatrix} \begin{bmatrix} \varepsilon_t^M \\ \varepsilon_t^l \\ \varepsilon_t^{\pi^*} \end{bmatrix} \tag{37}$$

with $[\varepsilon_t^{M\prime},\ \varepsilon_t^{l\prime},\ \varepsilon_t^{\pi^*}]' \backsim MVN(0,I)$, D^{MM} and D^{ll} lower triangular, and $T^D = [1,0,1]$.

After some elementary computations, the system can be rewritten as:

$$\begin{bmatrix} X_t^M \\ l_t \\ \pi_t^* \end{bmatrix} = \begin{bmatrix} C^M \\ C^l \\ 0 \end{bmatrix} + \begin{bmatrix} \Phi^{MM} & \Phi^{Ml} & \Phi^{M\pi^*} \\ \Phi^{lM} & \Phi^{ll} & \Phi^{l\pi^*} \\ 0 & 0 & I \end{bmatrix} \begin{bmatrix} X_{t-1}^M \\ l_{t-1} \\ \pi_{t-1}^* \end{bmatrix} + \begin{bmatrix} D^{MM} & 0 & D^{M\pi^*} \\ D^{lM} & D^{ll} & D^{l\pi^*} \\ 0 & 0 & S^{\pi^*\pi^*} \end{bmatrix} \begin{bmatrix} \varepsilon_t^M \\ \varepsilon_t^l \\ \varepsilon_t^{\pi^*} \end{bmatrix} \tag{38}$$

By calling $\tilde{\Phi}$ the block of the feedback matrix that refers to the stationary variables $X_t^S = [X_t^{M\prime}, l_t']'$, i.e.:

$$\tilde{\Phi} = \begin{bmatrix} \Phi^{MM} & \Phi^{Ml} \\ \Phi^{lM} & \Phi^{ll} \end{bmatrix}, \tag{39}$$

we can express the restrictions related to the long-run expected values of the stationary variables as follows:

$$\begin{bmatrix} \Phi^{M\pi^*} \\ \Phi^{l\pi^*} \end{bmatrix} = (I - \tilde{\Phi}) \begin{bmatrix} T^D \\ 0 \end{bmatrix}, \tag{40}$$

$$\begin{bmatrix} C^M \\ C^l \end{bmatrix} = (I - \tilde{\Phi}) \begin{bmatrix} \bar{C}_{3\times 1}^M \\ \bar{C}_{3\times 1}^l \end{bmatrix}, \tag{41}$$

$$\begin{bmatrix} D^{M\pi^*} \\ D^{l\pi^*} \end{bmatrix} = (I - \tilde{\Phi}) \begin{bmatrix} T^D \\ 0 \end{bmatrix} S^{\pi^*\pi^*}, \tag{42}$$

with $\bar{C}^M = [0, 0, \rho]'$ and $\bar{C}^l = [0, 0, 0]'$. Finally, the stationary condition of the vector X_t^S is satisfied by imposing that all the eigenvalues of $\tilde{\Phi}$ are below one, which implies that the stationary part of the system reverts to its long-run equilibrium $\lim_{s\to\infty} E_t X_{t+s}^S = [0, 0, \rho + \pi_t^*, 0, 0, 0]'$.

7.2 Identification of the Financial Factors

In order to identify the financial factors we impose the following restrictions:

1. The price of the government bonds hinges only upon the macrofactors $(\pi_t,\ g_t,\ r_t)$, the return forecasting factor $(l_{1,t})$ and the stochastic trend for inflation (π_t^*)

2. The spreads on BBB and B corporate bonds at all maturities are driven by a common credit factor, $l_{2,t}$

3. The spreads on B corporate bonds at all maturities are driven also by a rating-specific factor, $l_{3,t}$.

4. The one period expected excess returns on corporate and government bonds are driven by the three financial factors included in the state vector $(l_{1,t}, l_{2,t},\ l_{3,t})$;

These restrictions are satisfied by imposing that

- $\Phi^Q = (\Phi - \Sigma\Lambda_1)$ has zeros entries in the following positions:

$$\Phi^Q(j.i) = 0 \qquad \forall j = 1...i-1, 7 \wedge i = 5, 6, \tag{43}$$

-

$$\begin{aligned} \delta_{gov,1} &= [0,0,1,0,0,0,0] & (44)\\ \delta_{BBB,1} &= [0,0,0,0,1,0,0] & (45)\\ \delta_{B,1} &= [0,0,0,0,\delta_{B,1}(5),1,0]. & (46) \end{aligned}$$

-

$$\Lambda_1(j.i) = 0 \qquad \begin{cases} \forall i = 1,2,3,7 \\ \forall j = 7 \wedge i = 5,6 \end{cases} \tag{47}$$

More specifically, equations (43) and (44) make sure that restriction 1 holds, equations (43), (45) and (46) make sure that restrictions 2 and 3 hold, and (47) make sure that restriction 4 holds[16]. The restrictions on equation (43) are satisfied by imposing that:

$$\Lambda_1(j.i) = \begin{cases} \frac{\Phi(j.i)}{\Sigma(j,j)} & \forall j = 1 \wedge i = 5,6 \\ \frac{\Phi(j.i) - \sum_{k=1}^{j-1} \Lambda_1(k.i)\Sigma(j,k)}{\Sigma(j,j)} & \forall j = 2...i-1 \wedge i = 5,6 \end{cases} \tag{48}$$

7.3 Prior distribution

The two panels of Table (12) report the prior density of the parameters estimated in the model. $\mathcal{N}$ stands for Normal , $\mathcal{LN}$ for Log-Normal, and $\mathcal{U}$ for Uniform distribution. The parameters

[16] This can be easily seen by looking at the equations for the expected excess returns on a bond with maturity m and of type j, ($j = gov, BBB$ and B):

$$\begin{aligned} E_t er_{j,t\to t+1}(m) &= E_t p_{j,t+1}(m) - p_{j,t}(m+1) - r_t = a_j^{prem}(m) + b_j^{prem}(m) X_t \\ a_j^{prem}(m) &= b_j(m)\Sigma\Lambda_0 - \frac{1}{2} b_j(m)\Sigma\Sigma' b_j(m)' \\ b^{j,prem}(m) &= \begin{cases} b_j(m)\Sigma\Lambda_1, & j = gov \\ b_j(m)\Sigma\Lambda_1 + \delta_{j,1}, & j = BBB, B \end{cases}, \end{aligned}$$

with $a_j(m)$ and $b_j(m)$ given by Eq. (9) and Eq. (14) .

refer to the state space system reported in the paper and summarizes below:

$$
\begin{aligned}
Z_t &= A + BX_t + S\eta_t, \qquad \eta_t \sim \mathcal{N}(0, I) && \text{(Meas. Eq.)} \\
X_t &= C + \Phi X_{t-1} + \Sigma\varepsilon_t, \qquad \varepsilon_t \sim \mathcal{N}(0, I) && \text{(Trans. Eq.)}
\end{aligned}
$$

where the observable and state vectors are

$$
\begin{aligned}
Z_t &= [Z'_{macro,t}, Z'_{gov,t}, Z'_{spreads,t}, Z'_{survey,t}] \\
X_t &= [\pi_t, g_t, r_t, l_{1,t}, l_{2,t}, l_{3,t}, \pi^*_t]'
\end{aligned}
$$

with

$$Z'_{macro,t} = [\pi_t, g_t, r_t], \qquad Z'_{gov,t} = [y_{gov,t}(m)] \quad m = 3, 12, ..., 60, 120, \tag{49}$$

$$Z'_{BBB,t} = [s_{BBB,t}(m)], \qquad Z'_{B,t} = [s_{B,t}(m)] \quad m = 3, 12, ..., 60, 120, \tag{50}$$

$$Z'_{survey,t} = [F^{(12)}_{\pi,t},\ F^{(120)}_{\pi,t},\ F^{(3)}_{y_{gov}(120),t},\ F^{(12)}_{y_{gov}(120),t}]. \tag{51}$$

and the parameters of the transition equation are given by:

$$C = \begin{bmatrix} C^M \\ C^l \\ 0 \end{bmatrix}, \quad \Phi = \begin{bmatrix} \Phi^{MM} & \Phi^{Ml} & \Phi^{M\pi^*} \\ \Phi^{lM} & \Phi^{ll} & \Phi^{l\pi^*} \\ 0 & 0 & I \end{bmatrix}, \quad \Sigma = \begin{bmatrix} D^{MM} & 0 & D^{M\pi^*} \\ D^{lM} & D^{ll} & D^{l\pi^*} \\ 0 & 0 & S^{\pi^*\pi^*} \end{bmatrix}$$

with

$$\begin{bmatrix} C^M \\ C^l \end{bmatrix} = \left(I - \begin{bmatrix} \Phi^{MM} & \Phi^{Ml} \\ \Phi^{lM} & \Phi^{ll} \end{bmatrix} \right) \begin{bmatrix} \bar{C}^M \\ \bar{C}^l \end{bmatrix}$$

Finally, the parameters Λ_0 and Λ_1 are related to the stochastic discount factor used for pricing the government bonds:

$$m_{t+1} = \exp(-r_t - \frac{1}{2}\Lambda'_t\Lambda_t - \Lambda'_t\varepsilon_{t+1})$$

with $\Lambda_t = \Lambda_0 + \Lambda_1 X_t$.

Table 12: PRIOR DISTRIBUTION OF THE PARAMETERS

		Distr	Mean	Stdev			Distr	Mean	Stdev
$\Phi^{MM}(1,1)$		$\mathcal{N}$	0.900	0.100	$D^{lM}(1,j)$	$j=1,2,3;$	$\mathcal{N}$	0.000	0.008
$\Phi^{MM}(2,1)$		$\mathcal{N}$	-0.100	0.100	$D^{lM}(2,i)$	$i=1,4;$	$\mathcal{N}$	0.000	0.008
$\Phi^{MM}(3,1)$		$\mathcal{N}$	0.100	0.100	$D^{lM}(2,i)$	$i=2,3$	$\mathcal{N}$	-0.008	0.008
$\Phi^{MM}(1,2)$		$\mathcal{N}$	0.100	0.100	$D^{lM}(3,j)$	$j=1,2,3;$	$\mathcal{N}$	0.000	0.008
$\Phi^{MM}(2,2)$		$\mathcal{N}$	0.950	0.050	$S^{\pi^*\pi^*}$		$\mathcal{LN}^*$	-6.000	0.200
$\Phi^{MM}(3,2)$		$\mathcal{N}$	0.100	0.100	$\bar{C}^M(3)$		$\mathcal{N}$	0.020	0.001
$\Phi^{MM}(1,3)$		$\mathcal{N}$	-0.100	0.100	$X_0(i)$	$i=1,3$	$\mathcal{N}$	0.030	0.030
$\Phi^{MM}(2,3)$		$\mathcal{N}$	-0.100	0.100	$X_0(7)$		$\mathcal{U}^*$	0.060	0.025
$\Phi^{MM}(3,3)$		$\mathcal{N}$	0.900	0.100	$X_0(i)$	$i=2,4,5,6$	$\mathcal{N}$	0.000	0.030
$\Phi^{lM}(i,j)$	$\forall i,j$	$\mathcal{N}$	0.000	0.100	$\Lambda_0(i)$	$i=1,2,3,4.7$	$\mathcal{N}$	-1.000	2.000
$\Phi^{ll}(1,1)$		$\mathcal{N}$	0.600	0.100	$\Lambda_0(i)$	$i=5,6$	$\mathcal{N}$	-3.000	2.000
$\Phi^{ll}(2,2)$		$\mathcal{N}$	0.950	0.050	$\Lambda_1(i,4)$	$i=1,...,7$	$\mathcal{N}$	0.000	50.000
$\Phi^{ll}(3,3)$		$\mathcal{N}$	0.800	0.100	$\Lambda_1(i,j)$	$i=5,6,j=5$	$\mathcal{N}$	-25.000	50.000
$\Phi^{Ml}(2,2)$		$\mathcal{N}$	-0.100	0.100	$\Lambda_1(6,6)$		$\mathcal{N}$	-25.000	50.000
$\Phi^{Ml}(2,2)$	$\forall i,j\neq 2$	$\mathcal{N}$	0.000	0.100	$\delta_{BBB,0}$		$\mathcal{N}$	0.010	0.001
$D^{MM}(1,1)$		$\mathcal{LN}^*$	-2.500	1.000	$\delta_{B,0}$		$\mathcal{N}$	0.025	0.003
$D^{MM}(2,2)$		$\mathcal{LN}^*$	-1.500	1.000	$\delta_{B,1}(5)$		$\mathcal{N}$	1.000	1.000
$D^{MM}(3,3)$		$\mathcal{LN}^*$	-1.500	1.000	$A(i)$	$i=24,25$	$\mathcal{N}$	0.010	0.020
$D^{MM}(2,1)$		$\mathcal{N}$	0.000	0.008	$S(i,i)$	$i=4,...,21$	$\mathcal{LN}^*$	-2.000	1.000
$D^{MM}(3,i)$	$i=1,2$	$\mathcal{U}^*$	0.000	0.010	$S(i,i)$	$i=22,23$	$\mathcal{LN}^*$	-5.000	1.000
$D^{ll}(i,i)$	$i=2,3$	$\mathcal{LN}^*$	-1.500	1.000	$S(i,i)$	$i=24,25$	$\mathcal{LN}^*$	-2.000	1.000
$D^{ll}(i,j)$	$j\neq i$	$\mathcal{N}$	0.000	0.008					

* : For the uniform distribution, we report the lower and upper bounds of the support instead of the mean and standard deviation, respectively. For the log-normal distribution we report the ln of the random variable.

Our guidelines to choose the priors of the parameters are as follows. First, most of the priors on the parameters of the feedback matrix (Φ) and of the impact matrix (Σ) were chosen by first performing a preliminary VAR analysis on a system made of the three macroeconomic variables and three proxies for the financial variables. Second, we set a tight prior on the standard deviation of the stochastic trend, in line with our belief that over the period of the analysis the long run expected value of inflation moved smoothly through time. Second, we set the priors of Λ_0 and $\delta_{B,0}$ and $\delta_{BBB,0}$ such that the prior implied government yield curve is upward sloping ($\Lambda_0(i) \sim \mathcal{N}(-1,2), i = 1,2,3,4.7$) and that spreads are positive, with the average BBB spread lower than the B one ($\Lambda_0(i) \sim \mathcal{N}(-3,2), i = 5,6$ and $\delta_{B,0} \sim \mathcal{N}(0.025, 0.003)$ and $\delta_{BBB,0} \sim \mathcal{N}(0.01, 0.001)$). Finally, we set the prior on Λ_1 such that the average term premium is on government and corporate bonds is positive.