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ABSTRACT

Eurozone Sovereign Yield Spreads and Diverging Economic Fundamentals*

We construct daily real-time macroeconomic indices conditional on the rating of Eurozone countries. We uncover substantial explanatory power of our measures of economic fundamentals for yield dynamics beyond the traditional yield principal components. In particular, we find that the divergence in economic growth between AAA and non-AAA countries significantly explains the dynamics of sovereign yield spreads between the same groups of countries. The explanatory power of fundamentals is not subsumed by proxies of time-varying risk-aversion or by the perceived riskiness of the Eurozone banking sector. Finally, we cast this analysis of the Eurozone sovereign

yields in an innovative term structure model, featuring our real-time macroeconomic factors conditional on country ratings.

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Keywords: real-time economic growth and sovereign yield spread

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1 Introduction

Our current understanding of Treasury bond yields is that they are well described cross-sectionally by a low-dimensional factor model, namely the first three principal components of bond yields explain at least 95% of their variation (e.g., Litterman and Scheinkman, 1991).[1] Similarly, an optimal linear combination of current yields is able to forecast a large part of the variation of future yields (e.g., Cochrane and Piazzesi, 2005). Including macroeconomic factors seems to allow further forecasting improvements (e.g., Ang and Piazzesi, 2003), even when this information is not spanned by yields (Ludvigson and Ng, 2009; Duffee, 2011; Joslin, Priebsch, and Singleton, 2010).

While the virtually risk-free bond yields of U.S. Treasuries have been intensively studied, much less is known about the sovereign yields of issuers that are exposed to a different extent to the risk of default. Given the recent crisis events, this topic in fixed-income becomes especially relevant. The joint modeling of risk-free rates and credit spreads for corporate issuers is clearly the closest benchmark. However, there are substantial differences between a sovereign issuer and a corporate issuer. One difference in particular is that macroeconomic conditions affect directly the ability of a sovereign borrower to repay.

In this paper, we study the recent dynamics of European sovereign yield spreads. This is an interesting laboratory to study how different macroeconomic conditions affect interest rates and, implicitly default risk in a sovereign issuer environment. In fact, the presence of a common currency for issuers with different credit standings allows the separate identification of risk free rate and credit spread dynamics. At the same time, this setting features an homogeneous comparison without the confounding effects of differential monetary policy or exchange rate dynamics that would occur if we were to use risk-free benchmarks from a sovereign issuer with a different currency.

We take the traditional approach used for U.S. bond yields and estimate a term-structure model with sovereign credit spreads featuring both yield factors and macroeconomic factors. There are compelling reasons to expect spreads to be influenced by macroeconomic conditions. Theoretical models of default risk, as well as general equilibrium models with financial frictions and nominal rigidities, predict systematic relationships between spreads, output and/or inflation (e.g. Bernanke, Gertler and Gilchrist (1999)). Estimates of unconditional correlations indicate a close empirical link between sovereign spreads, the state of financing conditions faced by sovereign borrowers, and the business cycle.

Given the importance of macroeconomic fundamentals, it is crucial to rely on real-time measures that are not affected by the large biases induced by reporting lags or data revisions, because these issues seem to largely affect bond predictability results (Ghysels, Horan, and Moench, 2012). Furthermore, to ensure a tight identification with events that have unfolded only over the last few years, often with very quick dynamics, we also rely on an innovative

[1] Arbitrage-free term structure models deliver very similar three-factor representations (Dai and Singleton, 2000; Duffee, 2002).

methodology to measure economic conditions at a daily frequency, following the approach described in Beber, Brandt, and Luisi (2013).

We concentrate our analysis on European sovereign spread dynamics at a broad regional level. More specifically, we look at the aggregate sovereign spreads for all the Eurozone government issuers with a credit rating other than AAA versus sovereign yields of AAA Eurozone governments.[2] Measuring the yield spread based on credit ratings is a more appropriate approach than relying on single indicators (e.g., the debt to GDP ratio), because in principle ratings incorporate information on a whole range of factors that can affect the ability to repay, revolving around two dimensions, the growth outlook and the country risk (e.g., Standard & Poor's, 2011).

Consistent with the measurement of sovereign bond yield spreads, we calculate *real-time* daily macroeconomic factors conditional on country ratings. This methodology allows us to obtain a measure of macroeconomic growth divergence between AAA and non-AAA countries.

Our study begins by presenting linear unconditional correlations of benchmark sovereign yields and sovereign spreads on macroeconomic variables. In general, we find that both benchmark risk free rates and sovereign yield spreads are strongly related to real economic activity. The evidence for the role of macroeconomic fundamentals is much stronger than what was documented using lower frequency macroeconomic variables (e.g., Di Cesare et al. 2012).

We also find that real-time macroeconomic indices explain yield and yield spread dynamics beyond the traditional first three principal components.[3] Finally, we regress sovereign yield spreads at different maturities on their lagged values, the real-time macroeconomic factors, and a series of proxies for time-varying risk-aversion used before in the literature to explain Eurozone yield spreads (e.g., Favero, Pagano and vonThadden, 2010). We find a dominant role for macroeconomic fundamentals in explaining sovereign yield spreads, especially the economic growth spread, that is not subsumed by the other predictors. These preliminary results are good indicators of what we find in our affine term structure model; after all, our model predicts that yields and spreads are affine functions of the state variables. However, as noted elsewhere (Duffee (2002), Ang and Piazzesi (2003)), there are many insights to be gained from a no-arbitrage term structure model that cannot be inferred from simple reduced-form linear empirical analysis.

The multi-factor term structure model used in this paper is subject to restrictions imposed by the absence of arbitrage opportunities. Default risk is modeled using a doubly-stochastic intensity-based framework (Lando (1998), Duffie and Singleton (1999)), where risk-neutral instantaneous default loss rates ("instantaneous spreads") are assumed to be affine functions of the state variables. The state vector is comprised of both observable real-time macroeconomic

[2]One advantage of using aggregate regional data, in contrast to country-level data, is that noise from idiosyncratic country-level shocks is eliminated (Duffee (1999), Driessen (2005)), thereby allowing more efficient estimation of the role of macroeconomic variables in the term structure. One disadvantage is that we are unable to assess the relative importance of country-level versus aggregate shocks in the pricing of individual bonds.

[3]In concurrent work, Benzoni et al. (2012) also improve estimation of Eurozone CDS spreads over traditional affine models using a model of contagion with fragile beliefs.

factors and unobserved latent factors. Ideally, we would like to specify a completely observable state space to model yields and spreads, but our findings point to a crucial role played by latent factors in improving the fit of our model to market data. This result may be due to an overly restrictive state space (we include two macro factors), or it may reflect a well-known finding by Collin-Dufresne, Goldstein and Martin (2001) that, in addition to macroeconomic variables, there appears to be a common "unknown" factor in sovereign bond returns.

The remainder of the paper proceeds as follows. Section 2 describes the Eurozone yield data and the macroeconomic information used to construct our real-time macroeconomic factors. Section 3 carries out preliminary empirical analysis to highlight some interesting relations between Eurozone yield dynamics and the macroeconomy that will guide the modeling strategy. Section 4 presents the term structure model with latent and observable variables. Section 5 presents the result from model estimation and Section 7 concludes.

2 Data

In this Section, we first describe the data that we use to construct our risk-free rate benchmark for the Eurozone. We then explain how sovereign yield spreads are obtained as a difference between sovereign bond yields of all Eurozone governments and the risk-free rates. Finally, we describe the macroeconomic announcement data and the main ingredients of the methodology used to obtain the real-time Eurozone macroeconomic factors.

2.1 Risk-free Benchmark Sovereign Yields

The starting point for modeling the term structure of Eurozone interest rates is to obtain risk-free benchmark rates. Traditionally, these rates are obtained from central government bond issues with negligible credit risk. In the euro area, some central governments currently have AAA issuer rating or had this rating at times during our sample period. Table 1 contains a breakdown of Eurozone countries and their rating during our sample period, with an indication of the date when some of these countries were downgraded from AAA status.

The European Central Bank (ECB) releases a reference yield curve based on AAA-rated government bonds, obtained with a sound methodology that takes proper care of liquidity differences and interpolation for constant maturities. In the remainder of this paper, we consider this yield curve as our risk-free benchmark, and thus work with the assumption that term structures based on AAA-rated instruments are free of credit risk and therefore provide the reference rate for the borrowing costs of the Eurozone economy. Using a government bond curve rather than a swap curve as the risk-free benchmark has several advantages. First, the swap curve would incorporate counterparty risk, as it would need to be constructed from instruments that are more vulnerable to default of the involved counterparts. Second, the liquidity of interest rate swaps is largely affected by systemic risk premia reflecting balance-sheet exposure of market makers during periods heightened financial uncertainty. Finally, in addition to credit risk considerations, government bonds can be used as collateral, unlike swap contracts.

The ECB AAA yield curves are available daily, but they only start in late 2004. We extend the sample backward to the beginning of 1999, the start of the euro currency, using the euro risk-free yield curve Fair Market Curve Index (FMCI) from Bloomberg, that provides the composite yield of outstanding securities around each maturity point. The ECB and FMCI series turn out to be almost indistinguishable in the overlapping part of the sample.

Figure 1, upper panel, shows a plot of Eurozone risk-free benchmark yields in our sample period. In the upper part of Table 2, we also report summary statistics on risk-free yields at seven maturity points, from 3-months to 10 years.

2.2 Eurozone Sovereign Yield Spreads

Besides the AAA yield curve, the ECB releases an additional yield curve based on central government bonds from *all* euro area countries, regardless of their credit rating. Yields are obtained with the same robust methodology that tackles distortions due to differential liquidity and issues related to interpolation. We extend the sample backward before 2004 up to 1999 using Bloomberg yield data, as we did before for risk-free rates. Also in this case, the ECB and Bloomberg *ALL* Eurozone yields are very similar for the overlapping part of the sample.

We compute Eurozone sovereign yield spreads as the differences between the *ALL* and the *AAA* Bloomberg (1999-2004) and ECB (2004-2012) yield curves. Figure 1, lower panel, shows the yield spread between *ALL* and *AAA* countries. These figures show the tremendous evolution of yield spreads in the last one third of the sample and the resulting challenge for term structure modeling techniques that are traditionally facing more stable dynamics. In the lower part of Table 2, we also report summary statistics for Eurozone sovereign yield spreads at seven maturity points, ranging from 3-months to 10 years.

2.3 Eurozone Real-time Macroeconomic Factors

We obtain data on the dates, release times, and actual released figures for 183 Eurozone macro releases covering the period from January 1999 through December 2012, for a total of more than 30,000 announcements over about 3,000 working days. This data is obtained from Bloomberg through the Economic Calendar screen, which provides precisely time-stamped and unrestated announcement data.[4] The Appendix describes in detail the set of macroeconomic news in our sample, including their frequency, source, and units of measurement.

Most macroeconomic indicators are released on different days and at different frequencies, making it difficult to process the flow of information in a systematic and consistent way. Furthermore, news on different indicators are frequently released simultaneously. Finally, the release frequency varies across different economic aggregates. Data releases of different economic indicators are usually observed at different frequency; e.g., GDP data are typically sampled quarterly, the unemployment data is instead released monthly. These features of our large

[4] The importance of using real-time versus final data in macroeconomic forecasting has been discussed extensively in the literature (e.g., Koenig et al., 2003).

cross-section of macroeconomic releases generate a sparse matrix of data that the methodology will have to take up.

Our aim is to extract a set of real-time macroeconomic factors describing the state of the Eurozone economy, in both its (time-varying) AAA constituent and ALL constituent. We first impose a specific economically motivated structure on the macroeconomic news flow. Based on both empirical evidence and economic rationale, we first separate the aggregate economy into two broad dimensions: the nominal, and the real side.[5] In practice, we split the set of announcements into nominal inflation-related announcements and news that relates to real growth. Growth data, in turn, come in two flavors - objective realizations of past economic activity and subjective often forward-looking views derived from surveys which we label "macroeconomic sentiment." Finally, economic activity can be split one last time into information relating to output versus employment.

Through this structure, we can potentially obtain two (inflation and growth), three (inflation, economic activity, and macroeconomic sentiment), or four (inflation, output, employment, and macroeconomic sentiment) factors:

$$\begin{array}{l} \bullet\ \text{Inflation} \\ \bullet\ \text{Growth} \begin{cases} \text{Economic Activity} \begin{cases} \text{Output} \\ \text{Employment} \end{cases} \\ \text{Macro Sentiment} \end{cases} \end{array}$$

where, for example, the Economic Activity factor is obtained from the combined information relating to Output and Employment. In that sense, the information is nested from right to left. An important innovation of our approach is to obtain these macroeconomic factors for different subset of countries, AAA and ALL, with this subsets potentially time-varying during our sample period.

We now rely on our ex-ante categorization of the news for each set of countries and, within each category subset, let the data speak for itself by extracting the first principal component of that subset of data, following the approach of Beber, Brandt, and Luisi (2013). They obtain principal components using correlation matrices that are suitably adjusted for autocorrelation and different sample length of macroeconomic releases.[6] Moreover, in order to obtain a real-time measure, we use a telescoping (with a common historical start date and rolling end dates) correlation matrix starting in 1999.

In summary, armed with this methodology, we obtain real-time daily measures of macroeconomic conditions conditional on country ratings. This allows us to compute precisely the spread in

[5] The economy is often separated into the nominal and real sides because shocks to the two should be separated and treated differently. For example, many argue, from the perspective of monetary policy, nominal shocks should be minimized, whereas real shocks should not be intervened upon. Other studies also suggest that a nominal and a real factor can account for much of the observed variation in major economic aggregates.

[6] The Appendix contains a summary of the Principal Component methodology employed by Beber, Brandt, and Luisi (2013).

fundamentals with the same frequency and with the same groups of countries that are used to obtain the spread in sovereign yields. Figure 2, upper panel, shows the real-time growth index for AAA and $noAAA$ countries. As can be readily seen, $noAAA$ countries exhibit stronger economic growth in some earlier part of the sample, more resilience during the 2008-2009 recession, but far lower growth in about the last 3-years of the sample. This graphical evidence foreshadows our empirical analysis in the next section of the paper and is well summarized in the lower panel of Figure 2, which shows the striking correlation between the spread in economic growth and the spread in yields.

3 Preliminary Empirical Analysis

As a natural starting point for the empirical analysis of Eurozone rates and the state of the economy, we first look at simple linear unrestricted relations between the yield curve and the real-time macroeconomic factor. This empirical analysis does not impose the necessary cross-equation restrictions implied by the absence of arbitrage that we use in the bond pricing model of the next Section. Nonetheless, these simple estimates provide strong indication on the nature of the relations we expect to find in estimation of the no-arbitrage model, besides providing some guidance on the model setup.

In Table 4, we show unconditional linear correlations of Eurozone yields and real-time macroeconomic factors. More specifically, Table 4, Panel A and B, show a strongly positive correlation between the level of risk-free rates at all maturities and Eurozone macroeconomic performance. The strongest relations tend to appear at the very short-end of the yield curve, monotonically decreasing for longer maturities. There seems to be a dominant role for Eurozone employment and a relatively less important position for output, with the overarching growth factor exhibiting correlation between 0.50 and 0.30 in the longer sample period.

Table 4, Panel C, focuses on sovereign yield spreads and, for consistency, differential real-time macroeconomic dynamics between AAA and ALL countries. Linear correlations are all positive and large across the board, suggesting that a positive macroeconomic spread (AAA countries outperforming ALL countries) is correlated with a larger yield difference between ALL and AAA countries. This effect seems to have a slightly increasing pattern with yield maturity. In terms of macroeconomic aggregates, the differential in output seems to be relatively more important than employment divergences, with the overarching differential growth factor exhibiting very large correlations above 0.70 for all yield spreads at 6-month maturities or longer.

In Table 5, we deepen our analysis and present unconditional correlations between the first three principal components of the yield curve and real-time macroeconomic factors. More specifically, Panel A and B shows the results for AAA risk-free rates. All macroeconomic factors seem to be highly correlated with level and slope of risk-free yields. If anything, Eurozone employment seems to have a relatively stronger role for the first yield principal component and Eurozone output seems slightly more correlated with the second principal component. The third principal component is generally less correlated with real-time macro factors, with the exception of macroeconomic sentiment. In summary, for the longer sample period, the overarching macro growth factor is substantially correlated with level, slightly less with slope, and even less with the third principal component.

Table 5, Panel C, presents evidence of linear correlation between the principal components of sovereign yield spreads and real-time macroeconomic differentials. More specifically, we find a large positive correlation between the average level of yield spreads and macroeconomic outperformance of AAA countries. For example, we find that the real-time difference in the most general macroeconomic growth factor has a 0.75 correlation with the first principal component of yield spreads. Correlations with higher-order principal components are weaker and of more difficult interpretation.

Table 6 shows the explanatory power of Eurozone real-time macroeconomic factors on the yield curve beyond the first three principal components. Specifically, the empirical exercise is to understand whether macroeconomic information has any explanatory power for yield residuals from a regression of yields on three principal components. This is admittedly a very tough test, as the first three principal components typically explain almost the entirety of yield variation.

In Panel A, we perform this exercise with AAA yield residuals. The real-time Eurozone growth factor is remarkably strong, with explanatory power between 2% and 12% at different maturities. In Table 6, panel B, we carry out the same exercise for ALL yield residuals. Here the explanatory power of real-time macro factors seems somewhat subdued overall, with larger importance at the very short-end of the yield curve. Finally, Table 6, Panel C, looks at how real-time macroeconomic differentials explain sovereign yield spread residuals. The differential in growth plays an important role, especially at the short term, which seems to be driven by the economic activity differentials and much less by the macroeconomic sentiment differential.

In Table 7, we focus on sovereign yield spreads and measure the explanatory power of the real-time growth factor and factor differentials in a simple linear specification. In some specifications, we control for other explanatory variables, like VIX and the U.S. corporate default spread, that previous literature has used to show the effect of time-varying risk aversion on sovereign yield spreads (e.g., Longstaff et al., 2011; Favero, 2013). We also use a set of news dummies for the days in our sample featuring important events related mostly to institutional policy decisions. These news items are obtained from Zoli (2013) and refer to international events and country-specific events for Italy, the largest sovereign bond issuers outside the AAA rating group. In Panel A, we report the results for the 5-year maturity. We can readily observe that the growth spread is a significant explanatory variable for sovereign yield spreads, generating a large R^2. The log of VIX is also statistically significant, consistent with earlier literature, but it is does not drive out the explanatory power of fundamentals and is thus likely to contain different information. The U.S. default spread instead is never significant, suggesting that European sovereign yield spread dynamics have been somewhat unrelated to the general pattern of corporate credit risk. The good news dummies are all statistically significant, as well as the international bad news dummies, with the expected signs. Still, the divergence in economic fundamentals is shown to play an additional role. In the last two columns, we include the iTraxx credit default swap index for subordinated debt of European financial institutions, which is available after June 2004. This is clearly a very strong explanatory variable, as the risk of banks in this sample period is tightly intertwined with sovereign risk (see Acharya et al., 2012). However, the spread in economic growth, unlike VIX, is still a significant determinant of sovereign yield spreads even when the aggregate credit risk of the European banking sector is taken into account and specific news event days are controlled for. Table 7, Panel B, repeats the analysis for the 10-year maturity, obtaining very similar results.

In summary, this preliminary empirical analysis shows that macroeconomic real-time factors play an important role for Eurozone sovereign yields, over and beyond the traditional yield principal components, and beyond predictors related to time-varying risk aversion or risk of the banking sector. Eurozone macroeconomic growth, as the more general factor we construct, impacts risk-free yields. The differential in Eurozone growth between AAA and ALL countries has very strong explanatory power for Eurozone sovereign yield spreads. In the next Section, we develop a rigorous term-structure model that can account for all these dependencies, preserving the no-arbitrage restrictions.

4 A Term Structure Model with Latent and Observable Variables

In this section, we describe our model of the joint dynamics of the Eurozone risk-free benchmark sovereign yields and the Eurozone sovereign spreads. We specify processes for the risk-free rate, the risk-neutral instantaneous spreads on bonds of both rating classes, and the prices of systematic risk to be affine functions of the state variables. We first describe the general model with both latent and observable factors. We then explain how this structure changes when only latent variables are considered.

4.1 Model with Latent and Observable Variables

The state vector X_t consists of a set of *five risk factors*, the *three* latent factors $X_{1,2,3}$ and the *two* real-time observable macro factors. The first observable macro factor f_1 is the real-time $AAA-Growth$ factor $X^G_{AAA,t}$; the second observable f_2 is the growth spread $X^{G-spread}_{(AAA-noAAA),t}$ defined as the difference between the $AAA-Growth$ and $no-AAAGrowth$ real-time factors $X^{G-spread}_{(AAA-noAAA),t} = X^G_{AAA,t} - X^G_{noAAA,t}$ (note that this factor can be re-written as a difference between $X^G_{All,t} - X^G_{AAA,t}$). Formally:

$$X_t \equiv \begin{bmatrix} X_{1,t} \\ X_{2,t} \\ X_{3,t} \\ X^G_{AAA,t} \\ X^G_{Spread,t} \end{bmatrix}$$

We assume that X_t evolves according to a multivariate Gaussian diffusion process under the physical measure P:

$$dX_t = -KX_t dt + \Sigma dW_t \tag{1}$$

where W_t is a vector of independent Brownian motions.[7] We have imposed the long-run means of all factors to be zero. This is done without any loss in generality, as the means cannot be separately identified from the constants in the equations for the risk-free rate and instantaneous spreads given below. Similarly, we have normalized the unconditional variances of the factors to equal one, as these are not separately identified from the factor loadings on these variables in the equations for the risk-free rate and instantaneous spreads. Restrictions are placed on the elements of Σ such that the innovations to the latent factors are mutually independent and independent of the innovations to the macro factors. Finally, the matrix governing mean-reversion is specified as:

$$K = \begin{pmatrix} k_{11} & 0 & 0 & 0 & 0 \\ k_{21} & k_{22} & 0 & 0 & 0 \\ k_{31} & k_{32} & k_{33} & 0 & 0 \\ 0 & 0 & 0 & k_{f_1 f_1} & k_{f_1 f_2} \\ 0 & 0 & 0 & k_{f_2 f_1} & k_{f_2 f_2} \end{pmatrix} \tag{2}$$

The zero-restrictions in the off-diagonal blocks of (2) are imposed to reduce the dimensionality of the parameter space.

The instantaneous benchmark AAA risk-free rate r_t is determined according to:

$$r_t = \delta_{AAA,0} + \delta_{AAA,1} X_{1,t} + \delta_{AAA,2} X_{2,t} + \delta_{AAA,3} X_{3,t} + \delta_{AAA,f_1} X^G_{AAA,t} + \delta_{AAA,f_2} X^G_{Spread,t} \tag{3}$$

The instantaneous bond yield for the *All* rating class y_t is determined according to:

$$y_t = \delta_{All,0} + \delta_{All,1} X_{1,t} + \delta_{All,2} X_{2,t} + \delta_{All,3} X_{3,t} + \delta_{All,f_1} X^G_{AAA,t} + \delta_{All,f_2} X^G_{Spread,t}. \tag{4}$$

As with the risk-free rate, we assume that s_t^Q is an affine function of the state:

$$s_t^Q = \gamma_0 + \gamma_1 X_{1,t} + \gamma_2 X_{2,t} + \gamma_3 X_{3,t} + \gamma_{f_1} X^G_{AAA,t} + \gamma_{f_2} X^G_{Spread,t} \tag{5}$$

for bonds with rating other than AAA. The loadings on the factors in (5) are allowed to differ across rating categories. The inclusion of macro factors in (5) extends intensity-based models that contain only latent factors, such as Duffee (1999) who allowed three latent factors to drive the risk-neutral intensity, two of which were the determinants of the risk-free rate. The specifications (3) and (5) are sufficiently general to allow all three latent factors to affect Treasury yields and spreads. Whether such generality is necessary, given the inclusion of macro variables in these equations, as well as our findings above that only a few factors are necessary

[7] In the terminology of Duffee (2002), our model is part of the essentially affine ($EA_0(6)$) class of term structure models.

to capture most of the variation in yields and spreads, will be borne out by our estimates.

Note that equations (1), (3) and (5) imply that r_t and s_t^Q could become negative, depending upon the configuration of realised values for the Gaussian state variables. Of course, it is desirable to have processes for interest rates and spreads that are always positive. In the results reported below, it turns out that r_t, s_t^Q remain positive throughout the sample.

Finally, we assume that the prices of bonds are arbitrage-free, which implies the existence of a stochastic discount factor and an associated equivalent martingale measure Q. In line with the affine term structure literature, we assume that the market prices of systematic risk Λ_t are affine in the factors:

$$\Lambda_t = \lambda_0 + \lambda_1 X_t \tag{6}$$

where

$$\lambda_0 = \begin{pmatrix} \lambda_{0,1} \\ \lambda_{0,2} \\ \lambda_{0,3} \\ \lambda_{0,f_1} \\ \lambda_{0,f_2} \end{pmatrix} \text{ and } \lambda_1 = \begin{pmatrix} \lambda_{1,(1,1)} & 0 & 0 & 0 & 0 \\ \lambda_{1,(2,2)} & \lambda_{1,(2,2)} & 0 & 0 & 0 \\ \lambda_{1,(3,1)} & \lambda_{1,(3,2)} & \lambda_{1,(3,3)} & 0 & 0 \\ 0 & 0 & 0 & \lambda_{1,(4,4)} & \lambda_{1,(4,5)} \\ 0 & 0 & 0 & \lambda_{1,(5,4)} & \lambda_{1,(5,5)} \end{pmatrix}$$

The structure of λ_1 is chosen to achieve a manageable dimensionality of the parameter space.

Under our assumptions, the price of a Eurozone risk-free benchmark bond with N periods left to maturity at time t is:

$$P_t(N) = E_t^Q \left[\exp\left(-\int_{u=t}^{t+N} r_u du \right) \right] \tag{7}$$

where $E_t^Q(\cdot) \equiv E^Q(\cdot|I_t)$ is the expectation under Q conditional on the information set at time t. The price of a zero-coupon sovereign bond with rating other thanAAA is given by:

$$V_t(N) = E_t^Q \left[\exp\left(-\int_{u=t}^{t+N} \left(r_u + s_u^Q \right) du \right) \right] \tag{8}$$

Using results in Duffie and Kan (1996), the expectations in (7) and (8) can be solved to give the following expressions:

$$P_t(\tau) = \exp\left(A_T(N) + B_T(N)^\top X_t \right) \tag{9}$$

and

$$V_{j,t}(\tau) = \exp\left(\tilde{A}_j(N) + \tilde{B}_j(N)^\top X_t \right) \tag{10}$$

where $A(\tau)$ and $B(\tau)$ are obtained as solutions to a set of ordinary differential equations (see Appendix B). Yields on the Eurozone risk-free benchmark curves and Eurozone sovereign bonds are therefore given by:

$$y_{T,t}(N) = -\frac{\ln P_t(N)}{N} = -\frac{1}{N}\left(A_T(N) + B_T(N)^\top X_t\right) \tag{11}$$

and

$$y_{j,t}(N) = -\frac{\ln V_{j,t}(N)}{N} = -\frac{1}{N}\left(\tilde{A}_j(N) + \tilde{B}_j(N)^\top X_t\right) \tag{12}$$

which implies that the sovereign bond spread at maturity N is:

$$\begin{aligned} S_{j,t}(N) &\equiv y_{j,t}(N) - y_{T,t}(N) \\ &= -\frac{1}{N}\left(\left[\tilde{A}_j(N) - A_T(N)\right] + \left[\tilde{B}_j(N) - B_T(N)\right]^\top X_t\right) \\ &\equiv -\frac{1}{N}\left(A_j(N) + B_j(N)^\top X_t\right) \end{aligned} \tag{13}$$

4.2 Model with latent factors only

The state vector X_t consists only of the set of *three* latent factors.

$$X_t \equiv \begin{bmatrix} X_{1,t} \\ X_{2,t} \\ X_{3,t} \end{bmatrix}$$

with X_t that evolves according to the same multivariate Gaussian specified in 1. The matrix governing mean-reversion is thus specified as:

$$K = \begin{pmatrix} k_{11} & 0 & 0 \\ k_{21} & k_{22} & 0 \\ k_{31} & k_{32} & k_{33} \end{pmatrix} \tag{14}$$

The zero-restrictions in the off-diagonal blocks of (14) are imposed to reduce the dimensionality of the parameter space.

The instantaneous benchmark AAA risk-free rate r_t is now determined according to:

$$r_t = \delta_{AAA,0} + \delta_{AAA,1}X_{1,t} + \delta_{AAA,2}X_{2,t} + \delta_{AAA,3}X_{3,t}. \tag{15}$$

The instantaneous bond yield for the *All* rating class y_t is determined according to:

$$y_t = \delta_{All,0} + \delta_{All,1}X_{1,t} + \delta_{All,2}X_{2,t} + \delta_{All,3}X_{3,t}. \tag{16}$$

Finally, we assume that the market prices of systematic risk Λ_t are affine in the factors, as in equation 6, and set risk parameters as:

$$\lambda_0 = \begin{pmatrix} \lambda_{0,1} \\ \lambda_{0,2} \\ \lambda_{0,3} \end{pmatrix} \text{ and } \lambda_1 = \begin{pmatrix} \lambda_{1,(1,1)} & 0 & 0 \\ \lambda_{1,(2,1)} & \lambda_{1,(2,2)} & 0 \\ \lambda_{1,(3,1)} & \lambda_{1,(3,2)} & \lambda_{1,(3,3)} \end{pmatrix}$$

The structure of λ_1 is chosen to achieve a manageable dimensionality of the parameter space.

5 Estimation Results

5.1 Estimation Procedure

We conduct joint estimation of the model for risk-free benchmark yields and sovereign spreads. The typical approach taken in the literature has been to impose orthogonality conditions in the model that permits estimation on a country-by-country basis or by rating-country category. In addition, the parameters related to the risk-free benchmark portion of these models are usually estimated in a first step before estimating the spreads term structure. In our setting, each of the latent factors can affect the valuation of all securities, and we also allow for rich interactions in the joint evolution of the latent factors and in the prices of systematic risk. By estimating the model jointly across all bonds (both Eurozone AAA and Eurozone ALL), we aim to obtain more efficient estimates. Furthermore, we can test our assumption that a common set of latent factors, in addition to macroeconomic variables, are needed to explain prices across risk-free benchmark and risky government bond markets.

The macro factors are assumed to be exogenous with respect to yields and spreads, so we can estimate the model in two steps. First, since a discretized version of the process for X_t in (1) is a vector autoregression (VAR) of order one, we estimate these parameters by OLS. In addition, we estimate the coefficients on the macro factors in the equations for the instantaneous risk-free rate and instantaneous spreads by OLS. We use the 3M benchmark yield to proxy for the risk-free rate.[8] Similarly, we utilise the lowest maturity spread available (3M) to estimate the coefficients on the macro factors in (5) for sovereign bonds.

In the second step we estimate the remaining parameters using maximum likelihood estimation. This sequential procedure for estimating a Treasury curve model with macro factors is similar to the method used by Ang and Piazzesi (2003). However, we assume that all yields and spreads are observed with measurement error and so the likelihood function and estimates of the latent factors are constructed using the Kalman filter (see, e.g., Duan and Simonato (1995) and Lund (1997)). Appendix B gives further details on the estimation procedure.

[8] If we use the ECB Funds Rate as the regressand, coefficient estimates and the R^2 statistic are similar to those obtained for the 3M benchmark yield. This suggests that the equation for the 3M benchmark yield resembles the ECB's reaction function.

5.2 Parameter Estimates

The estimated models provide a very good fit to the actual AAA and ALL yields and the resulting sovereign yield spread. Figure 3 shows actual and estimated yields using the full model with three latent factors and two observable factors. In the upper panel, we represent actual and estimated AAA yields at 10-year and 1-year maturity. For the longer maturity, the two lines are indistinguishable and the model does an excellent fitting job. For the shorter maturity, fitting is less precise but it is still very consistent and accurate all over the sample period. Figure 3, lower panel, shows the actual and estimated yield spread at the 10-year maturity. The fit is remarkable, especially if we consider the huge change in regime for spreads between the pre- and post-2007 period.

Figure 4 shows the three latent factors used in the latent-factor only estimation. We add three observed yield series for comparison purposes. We notice the large correlation between the (negative of) the first factor and the actual 10-year yield, between the second latent factor and the observed AAA 1-year yield, and between the latent third factor and the actual 10-year yield spread.

Table 8 reports estimates of the term structure model parameters. The left-hand side of the table shows the estimate for the full model with five state variables, the right-hand side reports the estimates for the model with latent variables only.

The parameters are grouped into the loadings on the AAA risk-free rate and ALL yields; those governing the persistence and cross-dynamics of the factors; and the market prices of systematic risk. Let us consider these in turn.

The estimated parameters for the *latent-only* model show that both instantaneous *risk-free* and *All* yields load positively on the three factors, with a relatively larger role for the second latent factor and a more marginal effect of the first factor. The estimated effect on the instantaneous sovereign yield spread, obtained as a difference between $delta_i^{ALL}$ and $delta_i^{AAA}$, shows the most prominent positive loading on the third latent factor. It also takes a slightly negative loading on the second factor, suggesting that yield spreads tend to decrease marginally with larger short-term AAA yields, and a slightly positive loading on the first factor, which also implies that spreads tend to decrease in longer-term AAA yields.

Figure 5 shows the three latent factors used in the latent-factor only estimation together with the two observable factors used in the full-model estimation. It is apparent that the third latent factor is very highly correlated with the second observable factor, that is, the economic growth divergence between AAA and $no - AAA$ countries. Intuitively, given the strong relationship between yield spreads and the third latent factor, this suggests a close relation between yield and growth spread. This graphical evidence is borne out in the parameter estimation.

The estimated parameters for the *full* model are interesting. We obtain a positive loading of both AAA and ALL instantaneous yields on the Eurozone AAA growth factor, suggesting that economic growth is associated with larger yields consistent with a Taylor rule interpretation.

The loadings on the growth differential between AAA countries and non-AAA countries instead are negative, especially for AAA yields. In this case, a larger divergence in economic performance tends to drive the yield of the safer countries lower, in a flight-to-quality type of effect. The estimated effect on the instantaneous yield spread, obtained as a difference between $delta_i^{ALL}$ and $delta_i^{AAA}$, is negative for Eurozone growth (the first observable factor X_{f_1}), suggesting that a better economic environment tends to drive down the European yield spread, as expected. At the same time, a larger economic divergence (second observable factor X_{f_2}) has a strong and positive relation on yield spreads.

The middle part of Table 8 contains the parameters of the matrix governing mean-reversion. Here we just notice the strong persistence of all the factors and the insignificant magnitudes of the few off-diagonal terms that in principle are allowed to deviate from zero. These estimates are clearly resulting from the daily frequency of our dataset.

The last part of Table 8 contains the parameters that are describing the market price of systematic risk. Here, the risk-premium effects of shocks to the latent factors tend to have less economic importance than the unconditional risk-premium effects identified by $\lambda_{0,i}$. At the same time, shocks to the observable factors seems to have potentially similar if not larger magnitudes than unconditional risk-premium effects. The off-diagonal terms in this case do not seem to be trivial, as they were for the mean-reversion matrix.

5.3 Loadings on Macro Factors

The factor loadings, denoted by $-B_i(N)/N$, give the initial impact of an innovation to a factor on risk-free AAA benchmark yields, ALL yields, and the resulting sovereign yield spreads at maturity N.

Figure 6 displays these loadings for maturities $N = 1, ..., 120$ months. The upper panel shows an economically important and positive effect of shocks to Eurozone growth (the first observable factor) on AAA and ALL yields, especially for shorter maturities. The effect of a shock on the Eurozone growth differential (the second observable factor) is instead only significant for the AAA yields, where it takes a negative sign consistent with flight-to-quality phenomena. However, the economic magnitude of shocks to the second observable factor on risk-free yields is about half of the effect of the first observable factor.

The lower panel of Figure 6 shows the same factor loadings on yield spreads. Here the situation is reversed in terms of economic magnitude, with the second observable factor exerting the strongest effects on yield spreads at all maturities, with only a slightly weaker effect at the longer end. When economic divergence is larger, the yield spread is also larger, as the estimated sign of Table 6 was hinting. The first observable factor helps reducing yield spreads somewhat, and more so at the shorter horizon. Growth in the eurozone is certainly helpful in reducing yield differentials.

5.4 Market Price of Risk

Figure 7 shows the market price of risk associated to the two observable factors. There is a large negative price of risk on the Eurozone growth factor, especially at the peak of the 2008-2009 crisis and during the more recent Eurozone crisis. The market price of risk implied by the Eurozone growth differential has been negligible until the end of 2008, but it has started to play an increasingly larger role since then and especially in the final part of the sample.

5.5 Variance Decompositions

We now look at the proportion of the variance in conditional forecast errors due to each of the factor innovations to better understand the relative importance of latent and observable macroeconomic factors. Table 9 reports variance decompositions of risk-free yields (Panel A) and yield spreads (Panel B) for different maturities and forecast horizons of 3, 12 and 60 months.

The proportion of unconditional variance of risk-free yields accounted for by the growth factor is decreasing with the maturity of yields: highest at the short and middle-ends of the yield curve, and smallest for the long-end. The largest effect is for the 3-month yield where growth factor account for 25% of the unconditional variance (where the forecasting horizon is one-year). The spread in growth factor has the opposite dynamics, with the largest proportion of unconditional variance explained for the 10-year security, up to 60% with the three-month forecasting horizon. In summary, the macro factors jointly explain an increasing proportion of risk-free yield variance, 25%, 41%, and 68% for the short, medium, long part of the yield curve (at the three-month forecast horizon).

Table 9, Panel B, shows the same analysis for sovereign yield spreads. The proportion of unconditional variance accounted for by the growth factor is now increasing with the maturity of yield spreads: lowest at the short and middle-ends of the yield curve, and highest for the long-end. The largest effect is for the 10-year yield spread where growth factor account for 59% of the unconditional variance (where the forecasting horizon is five year). The spread in growth factor has the opposite dynamics, with the largest proportion of unconditional variance explained for the 3-month yield spreads, up to 30% with the three-month forecasting horizon. In summary, the macro factors jointly explain an increasing proportion of yield variance, 32%, 34%, and 87% for the short, medium, long part of the yield curve (at the five-year forecast horizon).

5.6 Latent Factor Identification

We estimate two term structure models that contain in both cases three latent factors. It is instructive to try and identify what these latent factors are likely to represent, as this can enhance our understanding of the dynamics of sovereign yield spreads in a more formal way. Furthermore, in this case there is little insight about identification from the traditional term structure literature, as the latent factors typically represent level, slope, and curvature, and these are unlikely to seamlessly translate to an estimation setting entailing both risk-free rates and sovereign yield spreads.

In Table 10, we show the R^2 of univariate regressions of the estimated latent factors on a number of explanatory variables. Each of the regressors is orthogonalized with respect to all the other variables, to make sure that we pick up the genuine explanatory power. In Panel A, we use the latent factors obtained from the latent-only 3-factor model. In the upper part of the panel, we look at the full sample period and notice that the largest explanatory power for all three factors is given by the spread in real-time growth between AAA and $non-AAA$ Eurozone countries, with R^2 ranging from 27% for the first factor to 73% for the third latent factor. This is again very strong evidence that the largest explanatory power for Eurozone yields originates in economic growth.

In the lower part of panel A, we restrict the analysis to the most recent part of the sample, where a proxy for the risk of the Eurozone banking sector was available (namely, a credit default swap index for subordinated debt of Eurozone financial institutions). In this case, the real-time growth differential is still the best explanatory power for the first latent factor, whereas the second and third factor are very clearly comoving with bank credit risk.[9]

In Panel B of Table 10, we repeat a similar exercise using the three latent factors from the five-factor model, featuring also growth and growth differential as observable factors. In this case, we clearly do not include real-time growth in the set of explanatory variables, as these are explicitly identified by the two observable factors. We find that the first latent factor is well identified by a proxy for time-varying risk aversion, with the logarithm of VIX explaining up to 25% of its variation in the later part of the sample. The second latent factor instead is basically unrelated to VIX and is only well identified by the credit risk of European banking sector after 2004. Finally, the third latent factor looks similar to the first, in that both the VIX and the U.S. default spread explain up to about 30% and 60% of its variation in the full sample or later part of the sample, respectively.

In summary, this descriptive identification analysis suggests that the good estimation performance of our term structure model relies on observing explicitly macroeconomic conditions in real-time and on latent factors identifying to some extent the dynamics of the general attitude towards risk and the specific risk in the banking sector.

6 Conclusion

We construct daily real-time macroeconomic indices conditional on the rating of Eurozone countries. We uncover substantial explanatory power of our measures of economic fundamentals for yield dynamics beyond the traditional yield principal components. In particular, we find that the divergence in economic growth between AAA and non-AAA countries significantly

[9]The Eurozone bank credit risk causality is potentially misleading, because of the contemporaneous relation between Eurozone yield spreads and European bank risk and profitability (e.g., Acharya et al., 2013).

explains the dynamics of sovereign yield spreads between the same groups of countries. The explanatory power of fundamentals is not subsumed by proxies of time-varying risk-aversion or by the perceived riskiness of the Eurozone banking sector. Finally, we cast this analysis of the Eurozone sovereign yields in an innovative term structure model, featuring our real-time macroeconomic factors conditional on country ratings.

A Construction of Eurozone Real-time Macro Factors

We follow Beber, Brandt, and Luisi (2013) and rely on an ex-ante categorization of the news to extract the first principal component of that subset of data. Specifically, on each day of our sample t, we obtain for each news category i the first principal component from the correlation matrix $\Omega_{t,i}$ of the stationary news series in category i. We work with the correlation matrix to abstract from arbitrary scaling of data. We denote the $N_i \times 1$ principal component weights by $c_{t,j}$, where N_i is the number of news series in category i for each country.

The key inputs to our methodology are the within news category correlation matrices $\Omega_{t,i}$. Specifically, we need to calculate from historical data up through date t the correlation of all news series of category i that are "active" on that date, where active means that the news series was previously initiated and has not yet been terminated. There are two issues that need to be addressed in computing these correlation matrices. First, the data is in the form of an unbalanced panel due to some of the series being initiated after the start date of the estimation window. Second, the data is naturally persistent, partly due to autocorrelation of the data in announcement time, partly due to the cross-sectional misalignment of the news in calendar time, and partly due to the forward filling of missing data.

We address the first unbalanced panel issue by using a correlation matrix estimator along the lines of Stambaugh (1997), who shows how to adjust first and second moments estimates for unequal sample lengths. The intuition of his approach is to use the observed data on the longer series, along with a projection of the shorter series on the longer ones estimated when both are observed, to adjust the moments of the shorter time series.

To correct for the persistence in the economic data, we depart from the standard approach of Newey-West (1987). The data is locally constant, due to the forward filling, and over longer intervals only moderately (cross-) autocorrelated due to the statistical nature of the news series. This peculiar correlation structure is actually identical to that found in high-frequency asset prices, where asynchronous and infrequent trading creates a misaligned and locally constant panel of observations. Inspired by this literature (e.g,, Ait-Sahalia, Mykland, and Zhang, 2005) they devise an estimator to handle this specific structure of short versus long-horizon dependence. Specifically, the estimator subsamples the data at a sufficiently low frequency that overcomes the local constancy and then averages over the set of all possible estimators that start the subsampling schemes at different times.

At date t we sub-sample the forward filled news series backward at a monthly frequency and then compute a Newey-West estimate of the correlation matrix using four lags. We repeat the same for monthly sampling starting at dates $\{t-1, t-2, ..., t-d+1\}$ (assuming d days per month) and then average the resulting d correlation matrix estimates.

B Estimation of Term Structure Model using the Kalman Filter

Affine models can be naturally cast as state-space systems, where the observation equation links observable yields and factors to the state vector and the transition equation describes the dynamics of the state. The Kalman filter has been used to estimate affine term-structure models in many studies; early examples are Duan and Simonato (1995) and Lund (1997). In this appendix, we layout the state-space form of our model and provide further details on our estimation technique.

As stated in (11) and (13), zero-coupon Treasury yields and sovereign yield spreads are a linear function of the state:

$$y_{T,t}(N) = -\frac{1}{N}\left(A_T(N) + B_T(N)^\top X_t\right) \tag{17}$$

$$S_{j,t}(N) = -\frac{1}{N}\left(A_j(N) + B_j(N)^\top X_t\right) \tag{18}$$

As shown in Duffie and Kan (1996), the functions $A_T(N)$ and $B_T(N)$ in (17) and (18) can be obtained as solutions to the following set of ordinary differential equations (ODEs):

$$\begin{aligned}
\frac{dA(N)}{dN} &= -\left(\tilde{K}\tilde{\Theta}\right)^\top B(N) + \frac{1}{2}\sum_{i=1}^{N}\left[\Sigma^\top B(N)\right]_i^2 - \delta_0, \\
\frac{dB(N)}{dN} &= -\tilde{K}^\top B(N) - \delta
\end{aligned}$$

where

$$\delta = \begin{pmatrix}\delta_T & \delta_{f_1} & \delta_{f_2}\end{pmatrix}^\top$$

$$\tilde{K} = K - \Sigma\lambda_1$$

$$\tilde{K}\tilde{\Theta} = -\Sigma\lambda_0$$

Similar expressions obtain for the loadings in spreads.

In estimation, we utilize time series data of length T_N for zero-coupon Treasury bond yields at maturities *12M, 36M, 60M, 84M, and 120M* and sovereign yield spreads at maturities *12M, 36M, 60M, 84M and 120M*. We assume that each of the yields and spreads is observed with measurement error. Let Y_t denote the vector of observable variables:

$$Y_t \equiv \begin{pmatrix}Y_{T,t}^\top & Y_{S,t}^\top & X_{f_1,t} & X_{f_2,t}\end{pmatrix}^\top$$

where

$$Y_{T,t} \equiv \begin{pmatrix} y_{T,t}(12M) & \cdots & y_{T,t}(120M) \end{pmatrix}^\top$$

$$Y_{S,t} \equiv \begin{pmatrix} S_t(12M) & \cdots & S_t(120M) \end{pmatrix}^\top$$

Similarly, let ε_t denote the vector of measurement errors:

$$\varepsilon_t \equiv \begin{pmatrix} \varepsilon_{T,t}^\top & \varepsilon_{s,t}^\top & 0 & 0 \end{pmatrix}^\top$$

The measurement equations of the state-space system can thus be written as:

$$Y_t = d + ZX_t + \varepsilon_t \tag{19}$$

where d and Z are defined implicitly in (17) and (18). ε_t is assumed to be normally distributed with mean 0 and diagonal variance-covariance matrix H:[10]

$$\varepsilon_t \sim N(0, H)$$

A discretized version of the state dynamics in (1) is:

$$X_t = \Phi X_{t-h} + \eta_t \tag{20}$$

where $\Phi = \exp(-Kh)$ and

$$\eta_t \sim N(0, I)$$

We utilize data at a daily frequency, and so $h = 1/252$. Equations (19) and (20) form our state-space model.

In our baseline model, we use the method of maximum likelihood to estimate the parameters in step two of our estimation procedure conditional on OLS estimates of a subset of parameters obtained in step 1. More specifically, let Ψ_1 and Ψ_2 denote the vectors of parameters estimated in steps 1 and 2, respectively. In step two we maximize the conditional log-likelihood function:

$$\ln L(Y_t, \Psi_2) = \sum_{t=1}^{T_N} f\left(Y_t; \Psi_2, \hat{\Psi}_1\right)$$

where $\hat{\Psi}_1$ denotes the OLS estimate of Ψ_1. The log-likelihood is constructed using the Kalman filter. The Kalman filter recursions are initialized with the stationary mean and variance of the unobserved state variables. Standard errors are obtained numerically by evaluating the inverse Hessian matrix at the maximum likelihood estimates and under the assumption that parameters estimated in step 1 are estimated without error.

C Appendix: Macroeconomic News

This Appendix summarizes the main features of the Eurozone macroeconomic releases considered in our sample. Category is either employment (EMP), output (OUT), or macroeconomic

[10] Since H has been assumed to be diagonal, there is no serial correlation and cross correlation in the measurement errors. Elements on the diagonal are allowed to differ, so that the variance of measurement error depends on maturity.

sentiment (SEN). If the sample series is stationary in our sample, we make no adjustment (Adj.=0), otherwise we use first differences with respect to previous period (Adj.=1) or previous year (Adj.=12). We also indicate Units, Frequency (M for monthly, W for weekly, Q for quarterly), and the source of the release.

Category	Name Macro Release	Adj.	Units	Freq	Source
EMP	Belgium Unemployment Rate SA	1	Rate	M	National Bank of Belgium
EMP	Estonia Unemployment Rate	1	Rate	M	Estonian Labour Market Board
EMP	Estonia Average Gross Monthly Wages (Quarterly figures) YoY	0	Percent	Q	Statistical Office of Estonia
EMP	Finland Unemployment Rate	1	Rate	M	Finnish Statistics Office
EMP	France Non-Farm Non-Government Payrolls Total Quarterly Per-Chge	0	Rate	Q	INSEE National Statistics Offi
EMP	France Monthly Wage Index QoQ	0	Rate	Q	French Labor Office
EMP	France Unemployment Rate ILO Method - Mainland France	1	Rate	Q	INSEE National Statistics Offi
EMP	France Unemployment Rate ILO Method Net Change (000s)	0	Volume	Q	INSEE National Statistics Offi
EMP	France Unemployment Rate ILO Method - Mainland & Overseas Const.	1	Rate	Q	INSEE National Statistics Offi
EMP	France Jobseekers Total SA net change	1	Volume	M	French Labor Office
EMP	Germany Unemployment Change SA	1	Rate	M	Deutsche Bundesbank
EMP	Greece Unemployment Rate Monthly	1	Rate	M	National Statistical Service
EMP	Ireland Unemployment Rate SA	1	Rate	M	Central Statistics Office Irel
EMP	Ireland Total Persons on Live Register SA	1	Volume	M	Central Statistics Office Irel
EMP	Ireland Total Persons on Live Register SA MoM	0	Rate	M	Central Statistics Office Irel
EMP	Italy New Hourly Wages MoM SA 2005=100	0	Rate	M	ISTAT
EMP	Italy Unemployment Rate SA	1	Rate	Q	ISTAT
EMP	Netherlands Unemployment Registered SA Per	1	Rate	M	Dutch Statistics Office
EMP	Portugal Unemployment Rate NSA	1	Rate	Q	Instituto Nacional de Estatist
EMP	Portuguese Labor Cost Index: Year over Year Percentage Change	0	Percent	Q	Instituto Nacional de Estatist
EMP	Slovakia Unemployment Available to Work Rate	1	Rate	M	The Center for Labor, Family a
EMP	Slovakia Avg Monthly Real Wages Industry YoY	0	Rate	M	Statistical Office of the Slov
EMP	Spain Unemployment Level MoM Net Change Latest Rev	0	Volume	M	Spanish Labour Ministry
EMP	Spain Labor Costs Avg Monthly Labor Cost Worker YoY	0	Rate	Q	INE
EMP	Spain Unemployment Rate	1	Rate	Q	INE
EMP	Slovenia Unemployment Rate Unemployed of Active Population	1	Rate	M	Rep Statistical Office
EMP	Slovenia Avg Gross Real Wages YoY	0	Rate	M	Rep Statistical Office
EMP	Eurostat Unemployment Eurozone SA	1	Rate	M	Copyright Euro Communities
EMP	Eurostat Eurozone Employment SA WDA QoQ	0	Rate	Q	Copyright Euro Communities
EMP	Eurostat Labor Costs Nominal Values Eurozone YoY WDA	0	Rate	Q	Copyright Euro Communities
EMP	Eurostat Eurozone Employment NSA YoY	0	Rate	Q	Copyright Euro Communities
OUT	Austria GDP Constant Prices QoQ	0	Rate	Q	Austrian Institute of Economic
OUT	Austria Industrial Production MoM SA	0	Rate	M	Statistik Austria
OUT	Belgium GDP Constant 2008 Prices SA QoQ	0	Rate	Q	National Bank of Belgium
OUT	Estonia Chain Linked GDP Seas Working Day Adj QoQ	0	Rate	Q	Statistical Office Estonia
OUT	Estonia Retail Sale Enterprises Constant YoY	0	Rate	M	Statistical Office Estonia
OUT	Finland GDP Constant Prices SA QoQ	0	Rate	Q	Finnish Statistics Office
OUT	Finland GDP Working Day Adjusted	0	Rate	Q	Finnish Statistics Office
OUT	Finland Industrial Production Volume MoM SA 2005=100	0	Rate	M	Finnish Statistics Office
OUT	Finland Retail Sales Volume Index YoY Per	0	Rate	M	Finnish Statistics Office
OUT	France GDP QoQ	0	Rate	Q	INSEE National Statistics Offi
OUT	France Industrial Production MoM SA 2005=100	0	Rate	M	INSEE National Statistics Offi
OUT	France Manufacturing Production MoM SA 2005=100	0	Rate	M	INSEE National Statistics Offi
OUT	Germany GDP Chain Linked Pan German QoQ	0	Rate	Q	German Fed Statistical Off
OUT	Germany GDP Chain Linked Investment in Construction QoQ	0	Rate	Q	German Fed Statistical Off
OUT	Germany GDP Chain Linked Exports QoQ	0	Percent	Q	German Fed Statistical Off
OUT	Germany GDP Chain Linked Imports QoQ	0	Percent	Q	German Fed Statistical Off
OUT	Germany GDP Chain Linked Private Consumption QoQ	0	Percent	Q	German Fed Statistical Off
OUT	Germany GDP Chain Linked Government Consumption QoQ	0	Percent	Q	German Fed Statistical Off
OUT	Germany GDP Chain Linked Domestic Demand QoQ	0	Rate	Q	German Fed Statistical Off
OUT	Germany GDP Chain Linked Gross fixed capital investment QoQ	0	Rate	Q	German Fed Statistical Off
OUT	Germany Industrial Production MoM SA	0	Rate	M	Deutsche Bundesbank
OUT	Germany Manufacturing Orders MoM SA	0	Rate	M	Deutsche Bundesbank
OUT	Germany Retail Sales Constant 2005 Prices MoM SA	0	Rate	M	German Fed Statistical Off
OUT	Greece Real GDP QoQ SA	0	Rate	Q	National Statistical Service o
OUT	Greece Industrial Production YoY	0	Rate	M	National Statistical Service o
OUT	Greece Retail Sales YoY 2005=100 WDA	0	Rate	M	National Statistical Service o
OUT	Ireland GDP Constant 2005 Prices QoQ SA	0	Rate	Q	Central Statistics Office Irel
OUT	Ireland Industrial Production SA MoM 2000=100	0	Rate	M	Central Statistics Office Irel
OUT	Ireland All New Vehicle Registrations	1	Volume	M	Central Statistics Office Irel
OUT	Ireland Retail Sales Volume All Businesses MoM SA	0	Rate	M	Central Statistics Office Irel
OUT	Italy Real GDP QoQ SA WDA	0	Rate	Q	ISTAT
OUT	Italy Industrial Production MoM SA	0	Rate	M	ISTAT
OUT	Italy Industrial Orders MoM SA 2005=100	0	Rate	M	ISTAT
OUT	Italy Industrial Sales MoM SA 2005=100	0	Rate	M	ISTAT
OUT	Italy New Car Registrations YoY NSA	0	Rate	M	ANFIA
OUT	Italy Retail Sales MoM SA 2005=100	0	Rate	M	ISTAT

Eurozone Macroeconomic News (continued)

Category	Name Macro Release	Adj.	Units	Freq	Source
OUT	GDP at Real 2000 Prices Seasonally Adjusted in Euros QoQ	0	Rate	Q	Dutch Statistics Office
OUT	Netherlands Industrial Production MoM 2005=100 SA	0	Rate	M	Dutch Statistics Office
OUT	Netherlands Industrial Sales YoY 2005=100	0	Rate	M	Dutch Statistics Office
OUT	Netherlands Retail Sales Turnover Index 2000=100 YoY	0	Rate	M	Dutch Statistics Office
OUT	Portugal GDP Constant 2006 Prices QoQ	0	Rate	Q	Instituto Nacional de Estatist
OUT	Portugal Industrial Production Index MoM	0	Rate	M	Instituto Nacional de Estatist
OUT	Portugal Industrial Sales Index 2005=100 MoM	0	Rate	M	Instituto Nacional de Estatist
OUT	Portugal Retail Sales Index MoM	0	Rate	M	Instituto Nacional de Estatist
OUT	Slovakia GDP Constant Prices YoY	0	Percent	Q	Statistical Office of the Slov
OUT	Slovakia Industrial Production Index Adjusted	0	Percent	M	Statistical Office of the Slov
OUT	Slovakia Industrial Sales Constant Prices YoY	0	Rate	M	Statistical Office of the Slov
OUT	Slovakia Industrial Orders MoM	0	Rate	M	Statistical Office of the Slov
OUT	Slovakia Retail Sales Ex Motor Vehicles Constant YoY	0	Percent	M	Statistical Office of the Slov
OUT	Spain GDP SA Chained Linked at Constant 2008 Prices QoQ	0	Rate	Q	INE
OUT	Spain Industrial Production YoY 2005=100	0	Rate	M	Instituto Nacional de Estadist
OUT	Spain Industrial Production Workday Adjusted YoY	0	Rate	M	Instituto Nacional de Estadist
OUT	Spain Retail Sales Constant Prices 2005=100 YoY	0	Rate	M	INE
OUT	Spain Retail Sales Constant Prices WDA YoY	0	Rate	M	INE
OUT	Slovenia GDP Constant Prices YoY	0	Rate	Q	Statistical Office of the Repu
OUT	Slovenia Industrial Production MoM	0	Rate	M	Statistical Office of the Repu
OUT	Slovenia Retail Trade MoM	0	Rate	M	Statistical Office of the Repu
OUT	Eurostat GDP cons prices Euro QoQ	0	Rate	Q	Copyright Euro Communities
OUT	Eurostat GDP cons prices Euro Household CExp	0	Rate	Q	Copyright Euro Communities
OUT	Eurozone Government Expenditure cons prices	0	Rate	Q	Copyright Euro Communities
OUT	Eurostat GDP cons prices Euro Gross Fixed Cap Form	0	Rate	Q	Copyright Euro Communities
OUT	Eurostat Ind Production Euro Ex Constr MoM SA	0	Rate	M	Copyright Euro Communities
OUT	Eurostat New Orders Euro Manufact Ind Orders MoM SA	0	Rate	M	Copyright Euro Communities
OUT	Eurostat Euro Monthly Prod Construction SA MoM	0	Rate	M	Copyright Euro Communities
OUT	Eurostat Retail Sales Volume Eurozone MoM SA	0	Rate	M	Copyright Euro Communities
SEN	Belgium General Index Business Confidence	0	Value	M	National Bank of Belgium
SEN	Belgium SEN Indicator	0	Value	M	National Bank of Belgium
SEN	Finland Industrial Confidence Indicator	0	Value	M	Confederation of Finnish Indus
SEN	Finland SEN Indicator	0	Value	M	Finnish Statistics Office
SEN	France Manufacturing PMI Markit Survey Ticker	0	Value	M	Markit
SEN	France Services PMI Markit Survey Ticker	0	Value	M	Markit
SEN	France Business Confidence Manuf ANTt Index	0	Value	M	INSEE National Statistics Offi
SEN	Bank of France Business ANTtiment Indicator	0	Value	M	Banque De France
SEN	France Business Confidence General Prod Expect	0	Value	M	INSEE National Statistics Offi
SEN	France Business Confidence Personal Prod Expect	0	Value	M	INSEE National Statistics Offi
SEN	France Bus Conf Mfg Industry Demand Past 3 Month	0	Value	M	INSEE National Statistics Offi
SEN	Ifo Pan Germany Business Climate	0	Value	M	IFO Institute - Institut fuer
SEN	IFO Pan Germany Business Expectations	0	Value	M	IFO Institute - Institut fuer
SEN	ZEW Germany Assessment of Current Situation	0	Value	M	ZEW Zentrum fuer Europaeische
SEN	ZEW Germany Expectation of Economic Growth	0	Value	M	ZEW Zentrum fuer Europaeische
SEN	IFO Pan Germany Current Assessment	0	Value	M	IFO Institute - Institut fuer
SEN	Germany Manufacturing PMI Markit Survey Ticker	0	Value	M	Markit
SEN	Germany Services PMI Markit Survey Ticker	0	Value	M	Markit
SEN	GfK SEN	0	Value	M	GfK AG

Eurozone Macroeconomic News (continued)

Category	Name Macro Release	Adj.	Units	Freq	Source
SEN	Ireland Consumer ANTtiment Index	0	Value	M	IIB Bank
SEN	Italy Business Confidence	0	Value	M	ISTAT
SEN	Italy Services PMI Markit Survey Ticker	0	Value	M	Markit
SEN	Italy Manufacturing PMI Markit Survey Ticker	0	Value	M	Markit
SEN	Italy SEN Indicator SA	0	Value	M	ISTAT
SEN	Netherlands Producer Confidence	0	Price	M	Dutch Statistics Office
SEN	Netherlands SEN Seasonally Adjusted	0	Value	M	Dutch Statistics Office
SEN	Portugal SEN Indicator 3Mth Moving Average	0	Value	M	Instituto Nacional de Estatist
SEN	Portugal Economic Climate Indicator	0	Value	M	Instituto Nacional de Estatist
SEN	Slovakia Industrial Confidence Indicator	0	Yield	M	Statistical Office of the Slov
SEN	Slovakia SEN Indicator SA	0	Yield	M	Statistical Office of the Slov
SEN	Spain Business Confidence Indicator	1	Value	Q	Spanish Chamber of Commerce
SEN	Slovenia Sentiment Indicator SA	0	Value	M	Statistical Office of the Repu
SEN	EC Manufacturing Confidence Euro Ind Confidence	0	Value	M	European Commission
SEN	EC Composite PMI Output	0	Value	M	Markit
SEN	Eurozone Manufacturing PMI Markit Survey Ticker	0	Value	M	Markit
SEN	Eurozone Services PMI Markit Survey Ticker	0	Value	M	Markit
SEN	EC Economic Sentiment Indicator Eurozone	0	Value	M	European Commission
SEN	EC Euro Area Business Climate Indicator	0	Value	M	European Commission
SEN	EC Services Confidence Indicator Eurozone	0	Value	M	European Commission
SEN	ZEW Eurozone Expectation of Economic Growth	0	Value	M	ZEW Zentrum fuer Europaeische
SEN	Sentix Economic Indices Euro Aggregate Index	0	Value	M	ANTtix Behavioral Indices
SEN	EC SEN Indicator Eurozone	0	Value	M	European Commission

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Table 1: Rating Composition for Eurozone member countries

This table shows the breakdown of Eurozone in AAA or non-AAA rating categories with relevant change of rating dates.

Eurozone Member Country	Fitch Rating	From	To
Austria	AAA	1999	Actual Rating as 12 Oct '12
Finland	AAA	1999	end of sample
France	AAA	1999	end of sample
Germany	AAA	1999	end of sample
Netherlands	AAA	1999	end of sample
Luxemburg	AAA	1999	end of sample
Ireland	AAA	1999	06 March '09
Spain	AAA	1999	10 Dec '03
Belgium	AA	1999	end of sample
Italy	A-	1999	end of sample
Portugal	BB+	1999	end of sample
Spain	BBB	10 Dec '03	end of sample
Ireland	BBB+	06 March '09	end of sample
Greece	CCC	2001	end of sample
Slovenia	A-	2007	end of sample
Cyprus	BB+	2008	end of sample
Malta	A+	2008	end of sample
Slovakia	A+	2009	end of sample
Estonia	A+	2001	end of sample

Table 2: Summary Statistics on Eurozone Risk-free Benchmark Yields and Sovereign Spreads

This table reports summary statistics for Eurozone *AAA* risk-free benchmark yields and sovereign spreads. The yield spread is obtained as the difference between *ALL* Eurozone sovereign yield and *AAA* yield with the same maturities. Data are at daily frequency. The sample period for the ECB curves is 2004:09-2012:10, while the Bloomberg FMCI curves cover the period 1998:12-2012:10.

Maturity							Autocorrelation			
(Months)	Mean	SD	Skew	Kurt	Min	Max	Lag 1	Lag 2	Lag 3	Lag 4
ECB Benchmark Sovereign Yields - starting 2004/09/06										
3	1.83	1.41	0.27	1.61	-0.02	4.33				
6	1.89	1.44	0.24	1.56	-0.05	4.36				
12	2.00	1.42	0.21	1.60	-0.10	4.54				
36	2.45	1.16	-0.04	1.97	0.15	4.74				
60	2.86	0.94	-0.30	2.39	0.65	4.73				
84	3.19	0.77	-0.51	2.77	1.17	4.74				
120	3.56	0.63	-0.69	3.06	1.76	4.78				
Benchmark Sovereign Yields - Long Sample - starting 1998/12/09										
3	2.40	1.43	-0.15	1.89	0.02	5.06				
6	2.48	1.43	-0.13	1.90	0.01	5.21				
12	2.58	1.41	-0.15	1.92	0.01	5.27				
36	3.00	1.25	-0.32	2.27	0.12	5.35				
60	3.38	1.07	-0.37	2.55	0.62	5.38				
84	3.67	0.96	-0.36	2.71	1.11	5.55				
120	3.95	0.84	-0.33	2.72	1.66	5.64				
ECB Sovereign Spreads										
3	0.14	0.28	3.22	17.60	-0.80	2.33				
6	0.21	0.42	2.59	10.77	-0.62	2.83				
12	0.32	0.55	2.20	7.60	-0.17	3.17				
36	0.40	0.57	1.57	4.37	-0.03	2.46				
60	0.41	0.56	1.41	3.68	-0.01	2.14				
84	0.41	0.55	1.39	3.60	0.00	2.03				
120	0.42	0.53	1.37	3.57	0.01	1.95				

Table 3: Principal Components of Eurozone Risk-free Benchmark Yields and Sovereign Spreads

This table contains the principal component loadings for Eurozone *AAA* risk-free benchmark yields and sovereign yield spreads. The row labeled (*Variance (cum)*) displays the cumulative variance explained by each of the principal component.

Maturity	Principal Components Loadings						
(Months)	1st	2nd	3rd	4th	5th	6th	7th
	ECB Benchmark Sov Yields - from 2004.09						
3	-0.5	-0.3	0.5	-0.6	0.1	-0.2	-0.0
6	-0.5	-0.3	0.1	0.4	-0.5	0.5	0.1
12	-0.5	-0.2	-0.3	0.4	0.4	-0.5	-0.1
36	-0.4	0.2	-0.5	-0.4	0.2	0.4	0.3
60	-0.3	0.4	-0.2	-0.2	-0.5	-0.1	-0.7
84	-0.2	0.5	0.2	0.1	-0.3	-0.5	0.6
120	-0.2	0.5	0.5	0.3	0.5	0.3	-0.2
Variance (cum)	95.6	99.7	100.0	100.0	100.0	100.0	100.0
	Benchmark Sov Yields - from 1998.12						
3	-0.4	0.4	0.5	0.5	-0.3	0.0	-0.0
6	-0.4	0.4	0.1	-0.4	0.7	0.2	0.1
12	-0.4	0.2	-0.4	-0.4	-0.6	-0.2	-0.1
36	-0.4	-0.2	-0.5	0.5	0.3	-0.4	-0.2
60	-0.3	-0.4	-0.2	0.2	-0.1	0.5	0.7
84	-0.3	-0.5	0.2	-0.2	-0.1	0.5	-0.7
120	-0.2	-0.5	0.5	-0.3	-0.0	-0.6	0.2
Variance (cum)	95.4	99.6	99.9	100.0	100.0	100.0	100.0
	ECB Sovereign Spreads						
3	0.2	-0.5	-0.8	0.1	-0.2	0.2	0.0
6	0.3	-0.5	0.1	-0.4	0.5	-0.5	-0.1
12	0.4	-0.4	0.6	-0.0	-0.2	0.5	0.2
36	0.4	0.1	0.1	0.7	-0.2	-0.4	-0.3
60	0.4	0.3	-0.1	0.2	0.5	0.1	0.7
84	0.4	0.3	-0.2	-0.2	0.3	0.4	-0.6
120	0.4	0.3	-0.1	-0.5	-0.6	-0.3	0.2
Variance (marg)	1.7	0.1	0.0	0.0	0.0	0.0	0.0
Variance (cum)	96.2	99.3	99.7	99.9	100.0	100.0	100.0

Table 4: Correlations between Macro Factors, AAA Yields and Spreads

We show unconditional linear correlation coefficients between Eurozone real-time macroeconomic factors and sovereign risk-free rates (Panel A, B) and between macro factor differentials and yield spreads (Panel C). $EUaaaSEN$, $EUaaaOUT$, $EUaaaEMP$,$EUaaaEA$, $EUaaaGRO$ are AAA countries macroeconomic sentiment, output, employment, economic activity and growth, respectively. $EUdiff$ indicates the same macro indicators, expressed as a difference between AAA and $non-AAA$ countries.

Panel A: AAA yields and macro (1999-2012)

1999-2012	EUaaaSEN	EUaaaOUT	EUaaaEMP	EUaaaEA	EUaaaGRO
3m	0.45	0.49	0.82	0.56	0.49
6m	0.47	0.49	0.82	0.56	0.50
1y	0.49	0.49	0.80	0.56	0.52
3y	0.45	0.40	0.75	0.48	0.45
5y	0.42	0.34	0.70	0.42	0.41
7y	0.38	0.29	0.65	0.37	0.36
10y	0.33	0.24	0.59	0.31	0.31

Panel B: AAA yields and macro (2004-2012)

2004-2012	EUaaaSEN	EUaaaOUT	EUaaaEMP	EUaaaEA	EUaaaGRO
3m	0.43	0.46	0.96	0.53	0.45
6m	0.45	0.47	0.96	0.55	0.47
1y	0.45	0.46	0.95	0.54	0.47
3y	0.38	0.35	0.91	0.42	0.37
5y	0.31	0.25	0.86	0.32	0.29
7y	0.25	0.16	0.80	0.22	0.21
10y	0.14	0.03	0.69	0.08	0.08

Panel C: Yield Spreads and macro divergence (2004-2012)

2004-2012	EUdiffSEN	EUdiffOUT	EUdiffEMP	EUdiffEA	EUdiffGRO
SPR3m	0.28	0.53	0.20	0.41	0.54
SPR6m	0.34	0.65	0.31	0.57	0.70
SPR1y	0.35	0.67	0.32	0.58	0.72
SPR3y	0.37	0.69	0.29	0.59	0.75
SPR5y	0.38	0.72	0.30	0.62	0.78
SPR7y	0.38	0.72	0.30	0.63	0.79
SPR10y	0.36	0.71	0.29	0.64	0.79

Table 5: Correlations of Macro Factors with Yields and Spreads PCs

We show unconditional linear correlation coefficients between real-time macroeconomic factors factors and sovereign risk-free Principal Components (Panel A, B) and between macro factor differentials and yield spread Principal Components (Panel C). $EUaaaSEN$, $EUaaaOUT$, $EUaaaEMP$,$EUaaaEA$, $EUaaaGRO$ are AAA countries macroeconomic sentiment, output, employment, economic activity and growth, respectively. $EUdiff$ indicates the same macro indicators, expressed as a difference between AAA and $non-AAA$ countries.

Panel A: AAA yields PCs and macro (1999-2012)

	EUaaaSEN	EUaaaOUT	EUaaaEMP	EUaaaEA	EUaaaGRO
PC1	0.4406	0.4008	0.7547	0.4791	0.4477
PC2	-0.2043	-0.4111	-0.3577	-0.4103	-0.302
PC3	-0.2474	-0.0959	-0.0039	-0.1139	-0.2109

Panel B: AAA yields PCs and macro (2004-2012)

	EUaaaSEN	EUaaaOUT	EUaaaEMP	EUaaaEA	EUaaaGRO
PC1	0.3588	0.3245	0.9082	0.3978	0.348
PC2	-0.3972	-0.6101	-0.311	-0.6319	-0.5123
PC3	0.2549	0.1911	-0.0225	0.209	0.2512

Panel C: Yield Spreads PCs and macro divergence (2004-2012)

2004-2012	EUdiffSEN	EUdiffOUT	EUdiffEMP	EUdiffEA	EUdiffGRO
PC1	0.364	0.6935	0.2974	0.5967	0.7482
PC2	0.0981	0.1966	0.0646	0.2327	0.2509
PC3	-0.044	-0.0418	-0.2944	-0.1603	-0.1052

Table 6: Macro Factors and Principal Component Residuals

We show the explanatory power of macro factor for AAA risk-free rates and yield spreads beyond the first three Principal Components. Panels report the R^2 of univariate regressions where yield or yield spread residuals are regressed on each of the five macroeconomic factors in turn. Sample period is 2004-2012.

Panel A: *AAA* yield residuals and macro factors

2004-2012	EUaaaSEN	EUaaaOUT	EUaaaEMP	EUaaaEA	EUaaaGRO
aaa3m	8.24	6.65	0.23	5.29	7.64
aaa6m	3.00	3.52	0.00	2.89	3.23
aaa1y	12.60	7.39	0.88	5.76	10.43
aaa3y	11.67	10.09	0.06	8.56	11.34
aaa5y	3.77	1.13	1.18	0.66	2.41
aaa7y	5.12	5.65	0.18	5.34	5.67
aaa10y	3.68	1.44	1.04	0.88	2.54

Panel B: *ALL* yield residuals and macro factors

2004-2012	EUallSEN	EUallOUT	EUallEMP	EUallEA	EUallGRO
ALL3m	5.02	6.44	7.69	5.80	6.01
ALL6m	3.86	5.33	7.41	4.66	4.76
ALL1y	0.13	0.05	2.97	0.00	0.02
ALL3y	0.80	1.96	5.94	1.49	1.28
ALL5y	0.00	0.24	2.78	0.06	0.03
ALL7y	0.89	1.97	5.13	1.95	1.45
ALL10y	0.18	0.81	3.85	0.43	0.38

Panel C: Yield Spread Residuals and Divergence in Macro Factors

2004-2012	EUdiffSEN	EUdiffOUT	EUdiffEMP	EUdiffEA	EUdiffGRO
spr3m	1.18	5.34	4.98	13.31	9.34
spr6m	1.01	5.14	4.82	13.54	9.32
spr1y	0.81	1.75	1.68	2.90	1.97
spr3y	0.30	2.92	2.68	9.38	6.48
spr5y	4.95	0.93	0.66	1.30	0.02
spr7y	3.25	4.73	4.98	5.14	5.70
spr10y	2.60	0.00	0.00	5.73	1.65

Table 7: Explaining Yield Spreads

We show estimates of the following regression:

$$y_t - r_t = \alpha + \rho\,(y_{t-1} - r_{t-1}) + \beta X_t + \epsilon_t,$$

where here the $y_t - r_t$ denotes the yield spread for the 5-year maturity (Panel A) and the 10-year maturity (Panel B). X_t contains the set of explanatory variables that includes the real-time growth index of AAA countries, the real-time growth spread between AAA and $noAAA$ countries, the log of the VIX index, the U.S. credit spread, a set of bad/good international and Italian news from Zoli (2013), and the iTraxx credit default swap index for investment grade European Financial entities. The sample period extends from January 1999 (from June 2004 in columns 8 and 9) to December 2012. All of the regression are based on daily observations. The constant and the lagged yield spread are always included but not reported to save space. The $AdjustedR^2$ shows explanatory power excluding the lagged spread. Robust Newey-West t-statistics are reported in parentheses.

Panel A: 5-year maturity

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Growth	-0.09								
	-1.12								
Growth Spread	0.29			0.36	0.38		0.18		0.58
	1.90			4.07	3.95		2.70		3.27
Log(VIX)		0.20		0.55	0.52				0.01
		1.91		3.95	3.28				0.01
Cred			0.02		0.06				-0.07
			0.23		0.62				-0.29
Bad News						3.35	3.31		2.72
						1.82	1.80		1.50
Good News						-6.14	-6.16		-6.23
						-3.37	-3.39		-3.65
ITA Bad News						3.14	3.20		2.61
						1.24	1.26		1.04
ITA Good News						-4.23	-4.23		-4.10
						-1.86	-1.87		-1.84
Bank								0.01	0.01
								3.71	4.05
$Adj - R^2$	0.81	0.01	0.03	0.73	0.77	0.04	0.63	0.85	0.95

Panel B: 10-year maturity

	1	2	3	4	5	6	7	8	9
Growth	-0.05								
	-0.88								
Growth Spread	0.18			0.26	0.26		0.13		0.50
	1.61			3.66	3.59		2.24		3.07
Log(VIX)		0.19		0.45	0.46				-0.09
		1.94		3.80	3.25				-0.33
Cred			0.01		-0.03				-0.28
			0.11		-0.29				-1.28
Bad News						0.74	0.72		0.14
						0.36	0.35		0.07
Good News						-7.12	-7.14		-7.21
						-3.33	-3.35		-3.58
ITA Bad News						2.76	2.82		2.41
						0.89	0.90		0.79
ITA Good News						-6.41	-6.42		-6.35
						-2.51	-2.52		-2.48
Bank								0.01	0.01
								3.85	4.69
$Adj-R^2$	0.78	0.01	0.02	0.73	0.74	0.04	0.63	0.83	0.94

Table 8: Estimates of Term Structure Model Parameters

We show the estimated parameters of the term structure model in its full version (three latent factors $X_{1,2,3}$ and two observable factors X_{f_1,f_2}) and in its latent factor version only.

	Full Model					Latent Only		
	X_1	X_2	X_3	X_{f_1}	X_{f_2}	X_1	X_2	X_3
δ_0^{AAA}	0.0019							
δ_i^{AAA}x1000	0.0547	0.6811	0.1476	0.7142	-0.3736	0.09006	0.5376	0.1200
δ_0^{ALL}	0.0020							
δ_i^{ALL}x1000	0.2735	0.4581	0.7440	0.5310	-0.0461	0.1779	0.4976	0.3684
k_{1i}	0.9998	0	0	0	0	0.9995	0	0
k_{2i}	0.0018	0.9955	0	0	0	0.0003	0.9999	
k_{3i}	0.0003	-0.0006	0.9985	0	0	-0.0006	-0.0001	0.9996
$k_{f_1 i}$	0	0	0	0.9995	-0.0018			
$k_{f_2 i}$	0	0	0	-0.0005	0.9980			
$\lambda_{0,i}$	0.0801	-0.0250	-0.0405	-0.0106	-0.0001	0.0458	-0.0290	-0.0321
$\lambda_{1,(1i)}$	0.0192	0	0	0	0	0.0177	0	0
$\lambda_{1,(2i)}$	0.0278	0.0067	0	0	0	0.0517	0.0180	0
$\lambda_{1,(3i)}$	0.0065	0.0026	0.0032	0	0	0.0014	0.0016	0.0008
$\lambda_{1,(f_1 i)}$	0	0	0	0.0109	-0.0072			
$\lambda_{1,(f_2 i)}$	0	0	0	0.0015	-0.0015			

Log-likelihood = -334610; AIC = -.....; BIC = -...; Number of parameters = ...

Log-likelihood = -338885; AIC = -.....; BIC = -...; Number of parameters = ...

Table 9: Variance Covariance Decomposition

We show the proportion of the variance in conditional forecast errors due to each of the factor innovations, for different maturities, and forecast horizons. In Panel A, we forecast AAA-yield and in Panel B we forecast yield spreads.

Panel A: AAA-yields

Forecast Horizon	**3mo**	**1y**	**5y**
3-month			
X_1	0.34	0.46	0.60
X_2	0.19	0.10	0.03
X_3	0.22	0.19	0.09
X_{GRO}	0.24	0.25	0.22
$X_{GroDiff}$	0.01	0.00	0.07
5-year			
X_1	0.21	0.33	0.57
X_2	0.16	0.10	0.03
X_3	0.21	0.21	0.12
X_{GRO}	0.21	0.23	0.21
$X_{GroDiff}$	0.20	0.14	0.07
10-year			
X_1	0.17	0.27	0.58
X_2	0.07	0.05	0.02
X_3	0.07	0.08	0.06
X_{GRO}	0.08	0.08	0.06
$X_{GroDiff}$	0.60	0.53	0.28

Panel B: Yield Spreads

Forecast Horizon	**3mo**	**1y**	**5y**
3-month			
X_1	0.37	0.41	0.52
X_2	0.01	0.01	0.01
X_3	0.29	0.26	0.15
X_{GRO}	0.03	0.04	0.10
$X_{GroDiff}$	0.30	0.28	0.22
5-year			
X_1	0.19	0.30	0.52
X_2	0.17	0.10	0.03
X_3	0.20	0.20	0.11
X_{GRO}	0.27	0.29	0.27
$X_{GroDiff}$	0.17	0.10	0.07
10-year			
X_1	0.01	0.00	0.03
X_2	0.44	0.30	0.08
X_3	0.03	0.03	0.01
X_{GRO}	0.49	0.58	0.59
$X_{GroDiff}$	0.04	0.09	0.28

Table 10: Identification of Latent Factors

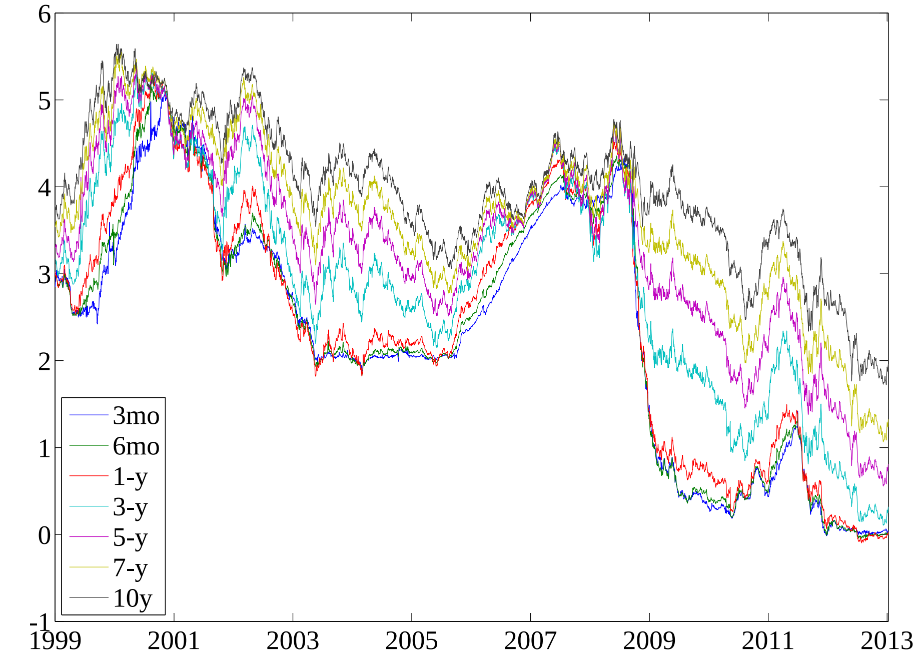
We report the adjusted R^2 of univariate regressions of the three estimated latent factors of the 3-factor (Panel A) and the 5-factor term structure model (Panel B) on the log of VIX, the corporate default risk premium ($Cred$), policy news event days from Zoli (2013) ($News$), and the iTraxx credit default swap index for investment grade European Financial entities ($Bank$). In Panel A, we also include the real-time growth of AAA countries and the real-time growth differential. All the regressors are orthogonalized with respect to each other. The sample period extends from January 1999 (from June 2004 in lower parts of the panels) to December 2012. All of the regression are based on daily observations.

Panel A: Latent factors in 3-factor model

Latent Factor	**1**	**2**	**3**
	1999-2012		
$logVIX$	0.09	0.00	0.04
$Cred$	0.00	0.08	0.02
$News$	0.01	0.02	0.04
$Growth$	0.00	0.35	0.05
$GrowthSpread$	0.27	0.47	0.73
	2004-2012		
$logVIX$	0.02	0.00	0.08
$Cred$	0.03	0.08	0.00
$News$	0.01	0.02	0.04
$Bank$	0.06	0.60	0.88
$Growth$	0.01	0.15	0.00
$GrowthSpread$	0.22	0.01	0.05

Panel B: Latent factors in 5-factor model

Latent Factor	**1**	**2**	**3**
	1999-2012		
$logVIX$	0.14	0.00	0.29
$Cred$	0.08	0.00	0.10
$News$	0.00	0.02	0.00
	2004-2012		
$logVIX$	0.25	0.00	0.60
$Cred$	0.21	0.01	0.58
$News$	0.01	0.02	0.00
$Bank$	0.05	0.48	0.02



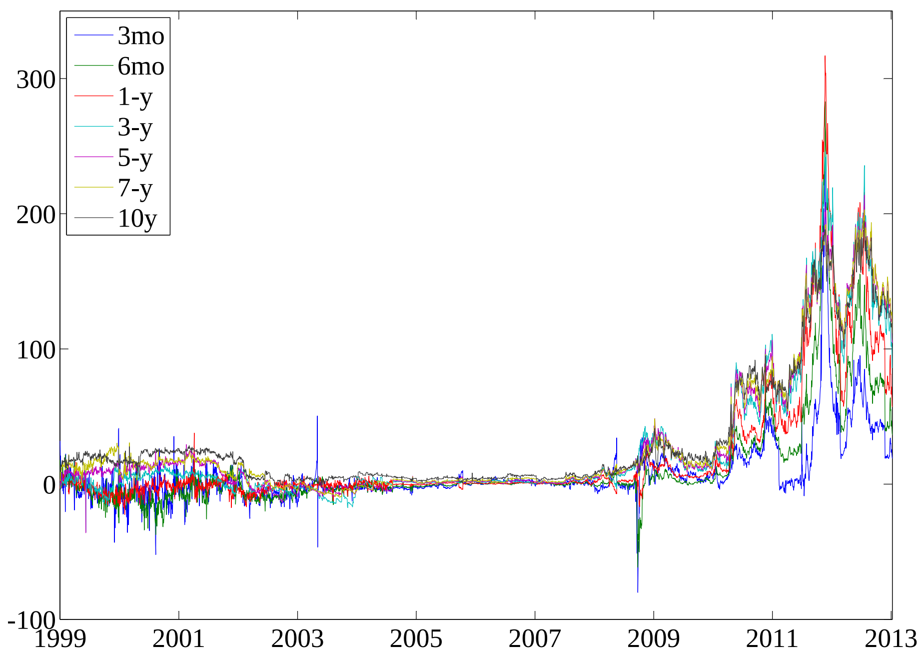
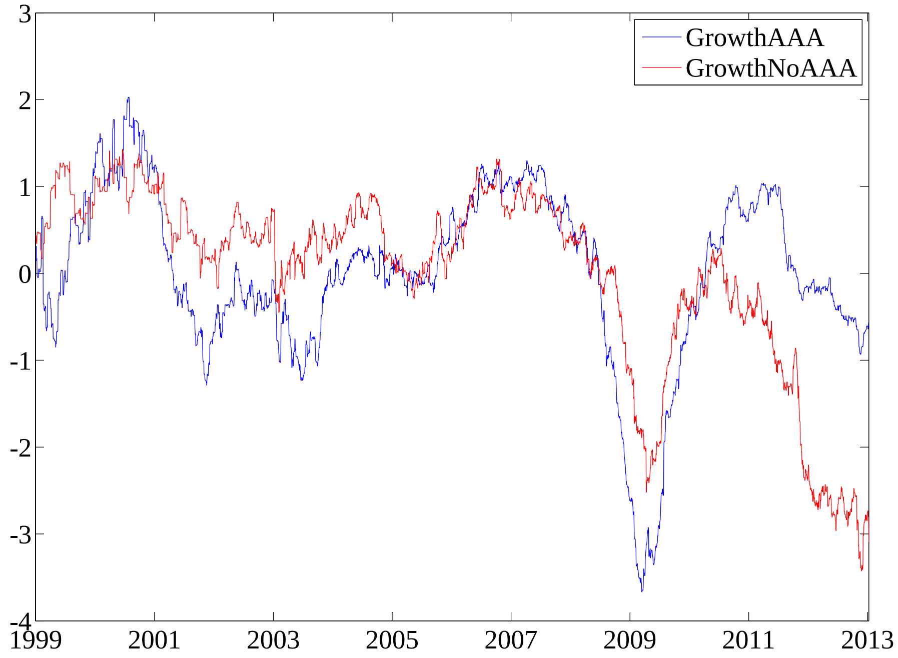


Figure 1: In the upper panel, we plot AAA yields for different maturities expressed as annual rates. In the lower panel, we plot the yield spread between noAAA and AAA issuers (in basis points) for different maturities.



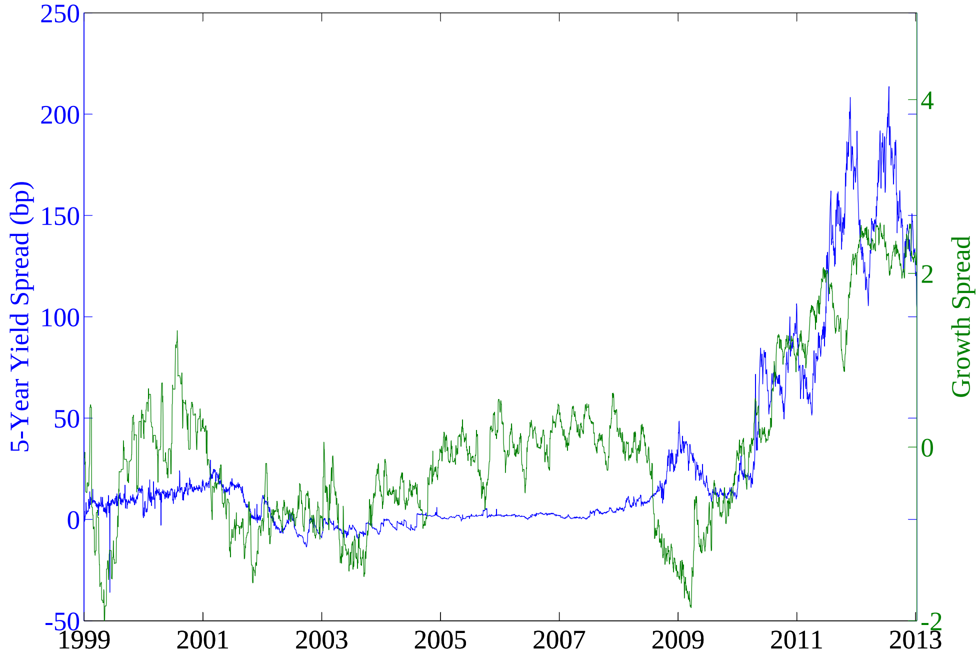
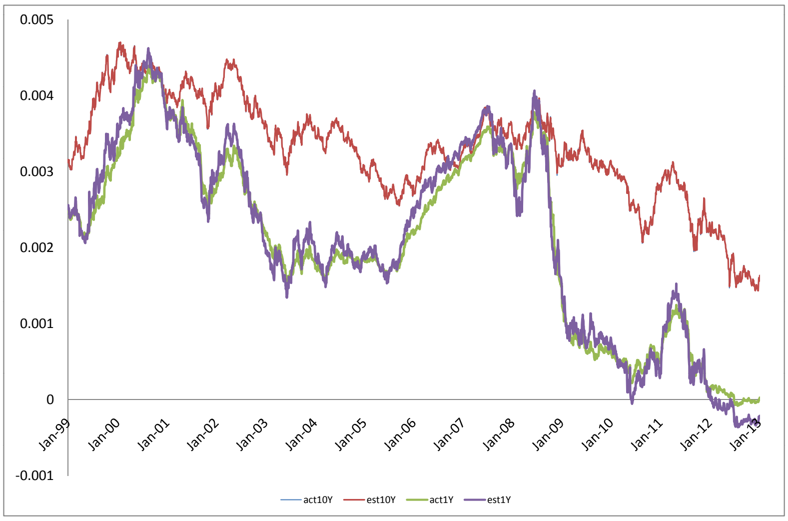


Figure 2: In the upper panel, we plot the real-time growth index for AAA and for no-AAA Eurozone countries. In the lower panel, we plot



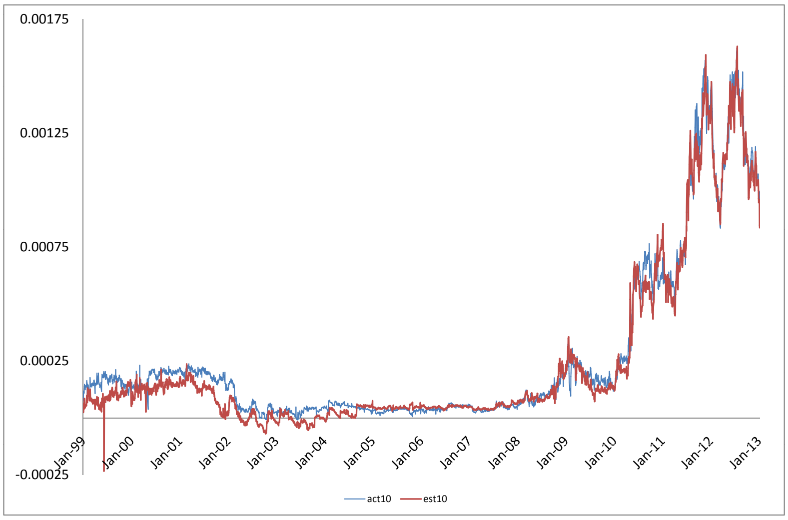


Figure 3: In this figure, we plot AAA actual and estimated yields and actual and estimated yield spreads.

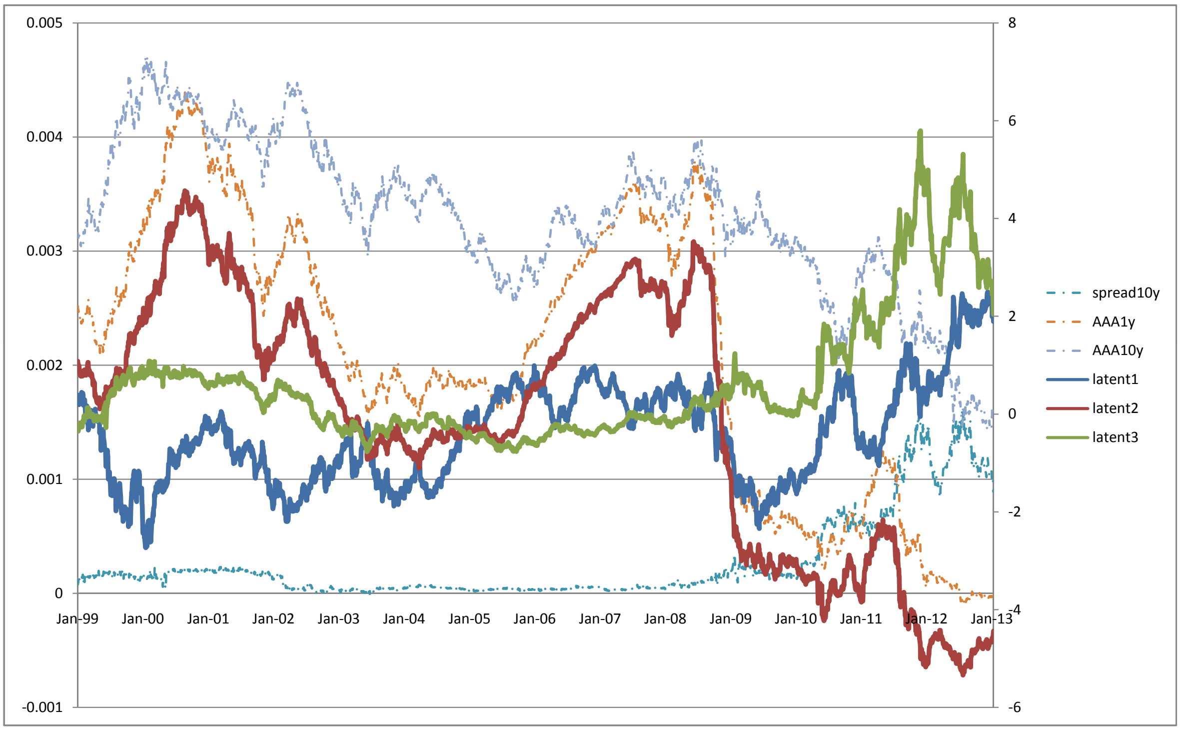


Figure 4: In this figure, we plot the three latent factors for the latent-only model together with actual yields.

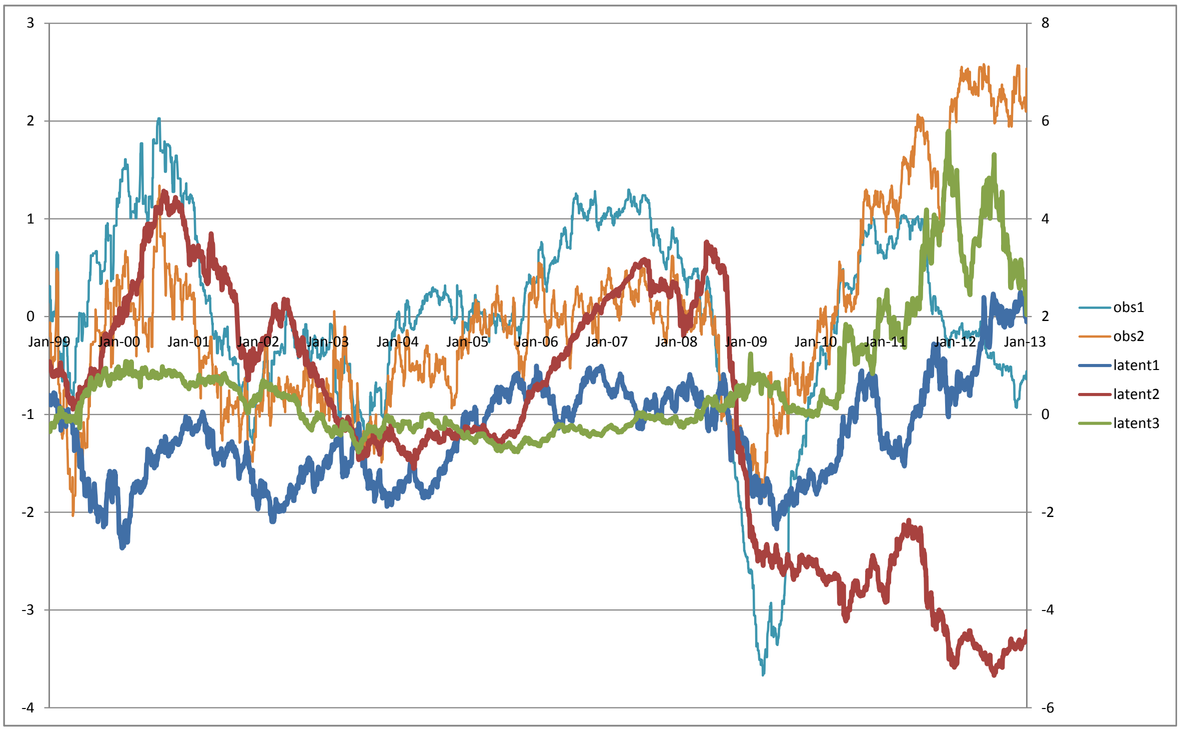
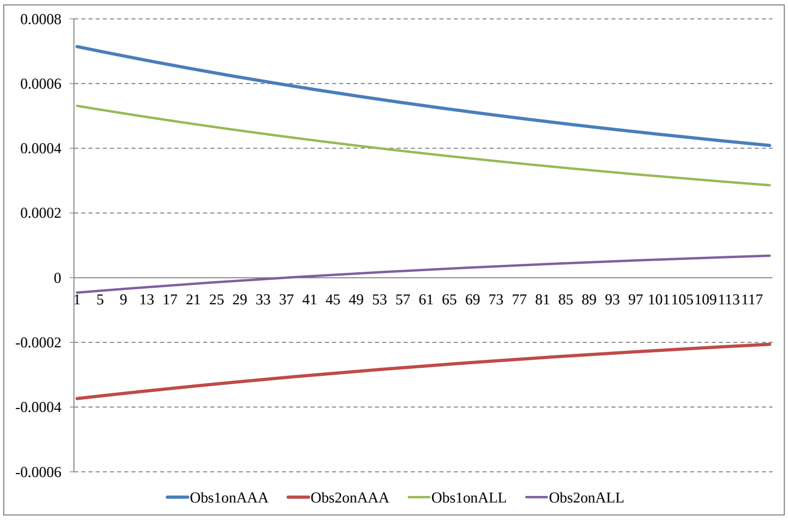


Figure 5: In this figure, we plot the three latent factors for the latent-only model together with the observable factors of the .



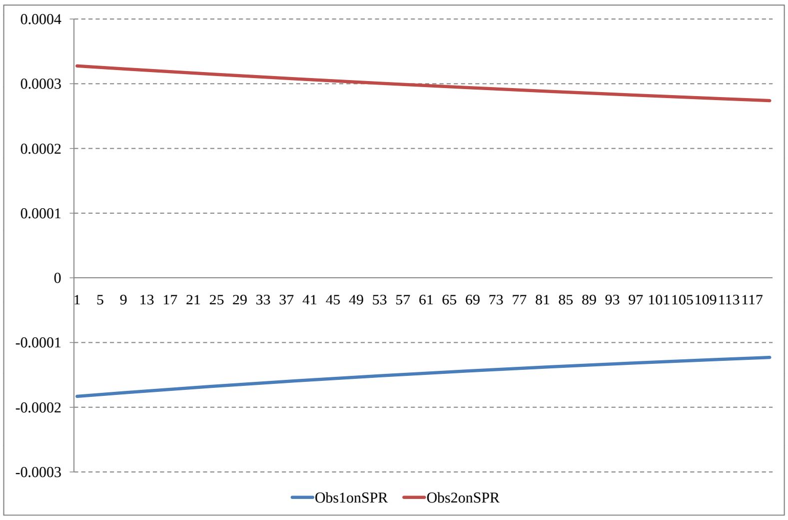


Figure 6: In this figure, we plot the loadings on the two observable factors (growth and growth differential) on AAA/ALL yields and yield spreads.

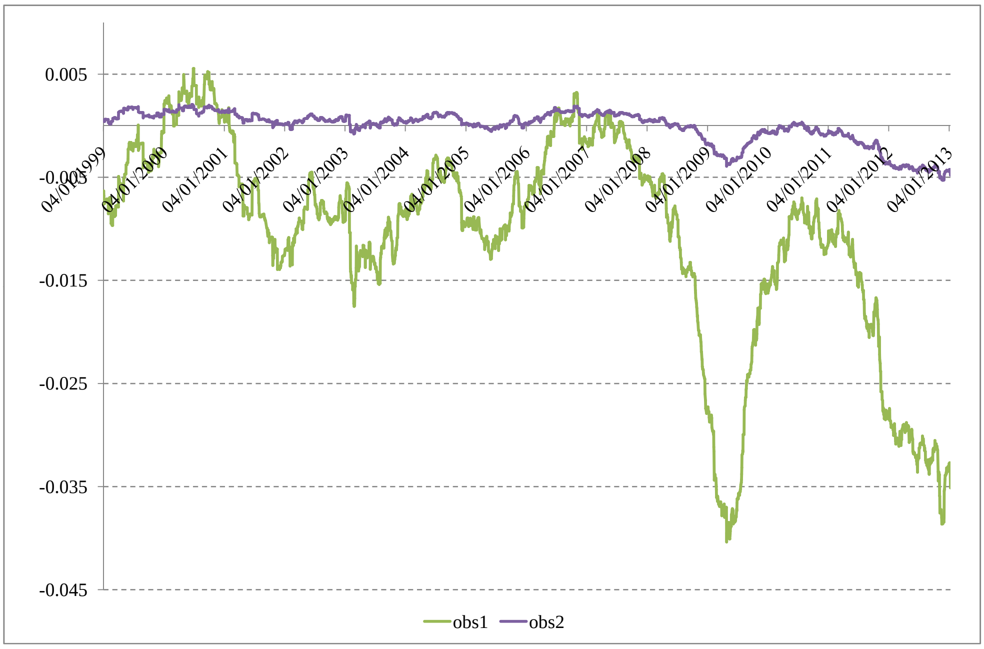


Figure 7: In this figure, we plot the market price of risk of the two observable factors (growth and growth differential).