The changing information content of market interest rates

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Abstract

This paper investigates the various factors underlying the pricing of US fixed income assets. In particular, we decompose movements in 10-year Treasury, swap, agency and corporate yields into five unobserved factors: the risk-free interest rate, a credit risk factor, a liquidity preference factor, and idiosyncratic shocks affecting Treasury yields and swap rates, respectively. Our findings indicate that the relative importance of these factors has shifted in recent years, with significant implications for the information content of market interest rates. First, Treasury yields have become increasingly divorced from the risk-free rate due to an increase in the volatility of idiosyncratic Treasury shocks. Second, spreads between the yields on various fixed income securities have been increasingly influenced by a number of different factors, making them harder to interpret.

1. Introduction

Financial markets play a critical role in the process of setting monetary policy. First, the influence of monetary policy on the real economy and inflation is largely transmitted through asset prices. Indeed, most economic activity is not directly affected by the overnight interest rate - the lever directly controlled by most central banks - but instead by longer-term interest rates and the wealth of economic agents. Second, central banks rely on financial markets for information to help inform their policy decisions. To that end, market interest rates summarise vast amounts of information about the expected course of monetary policy and the economy. The problem in both regards, though, is that many factors potentially influence market rates that are not necessarily related to monetary policy. In order to predict the consequences of their actions and to read correctly the signals from financial markets, monetary policymakers must have a firm understanding of the factors underlying movements in market rates.

This paper offers a statistical interpretation of the movements of key US market interest rates since 1993. In particular, we decompose weekly changes in 10-year Treasury, swap, agency and corporate yields into five unobserved factors: the risk-free interest rate, factors representing credit risk and liquidity preference, and idiosyncratic shocks affecting Treasury yields and swap rates, respectively. By concentrating on the underlying factors rather than the market interest rates themselves, we bring the financial market developments over that period into sharper focus. Moreover, the results indicate that the importance of individual factors has shifted in recent years, with significant consequences for the information content of market interest rates and, presumably, the appropriate investment and hedging strategies of private investors.

One important finding is that the extent of idiosyncratic movements in US Treasury yields has increased in recent years. Simply put, Treasury yields have become increasingly divorced from the risk-free interest rate due to a larger and more volatile idiosyncratic premium on those securities. This premium has presumably been moved in part by actual and prospective cutbacks in the supply of

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Treasury securities as the outlook for the federal budget swung in early 2000 towards sizeable surpluses. As a result, yields on government securities no longer serve as effectively as they once did as proxies for risk-free interest rates. The decomposition offers an alternative measure of the risk-free interest rate based on the common movements in the yields of all the assets considered.

The behaviour of private interest rates has also shifted importantly in recent years, as yield spreads on corporate bonds have been larger and more variable. Our results indicate that this pattern can only be partly attributed to the credit risk factor. Private yield spreads have also been influenced by an increase in the volatility of shocks to investors' preferences for liquidity, since private securities with different credit quality often have different degrees of liquidity as well, and by idiosyncratic movements in both Treasury yields and swap rates, the benchmarks against which corporate yield spreads are typically measured.

The paper is organised as follows. Section 2 describes our decomposition of US fixed income yields, and Section 3 shows the overall results from that exercise. Section 4 focuses on recent shifts in the behaviour of US fixed income markets and the lessons to be drawn for central banks, and Section 5 concludes.

2. A decomposition of US market interest rates

Our attempt to identify several fundamental factors that explain the yields on key US fixed income assets will focus on the rates on five different assets with maturities of around 10 years: an on-the-run Treasury security, an off-the-run Treasury security, an interest rate swap, a federal agency debt security and a corporate debt security. These securities are first described in some detail.

The ***on-the-run Treasury yield*** is that on the most recently issued 10-year Treasury note.[2] The amount of trading activity in this security is extensive, and its liquidity is remarkable.[3] An average of more than USD 200 billion of that security is estimated to have traded every week over the first three months of 2001. Bid-ask spreads on that issue are almost always below 1/2 basis point (in terms of yield) and are typically closer to 1/4 basis point. The impressive liquidity of the security (and other on-the-run Treasury issues) is partly related to its widespread use as a hedging instrument. More generally, the perception that this security is a very liquid instrument attracts investors employing strategies that involve intensive trading, which in turn makes the security more liquid.

The ***off-the-run Treasury yield*** considered is the par yield on a 10-year security derived from a smoothed yield curve estimated from the prices of off-the-run notes and bonds and some coupon strips.[4] Off-the-run Treasury securities are still quite liquid relative to other fixed income assets, with bid-ask spreads typically around or slightly greater than 1/2 basis point, but the market is not as deep or active as that for on-the-run issues.

The ***agency yield*** considered is based on a security issued by the Resolution Funding Corporation (Refcorp). Refcorp was established in 1989 to provide funding to the Resolution Trust Corporation for the resolution of insolvent thrifts, and it issued USD 30 billion of debt between 1989 and 1991. This debt is essentially free of credit risk: the coupon payments are backed by the full faith and credit of the US government, and the principal payments are fully collateralised by a special series of non-marketable zero coupon Treasury securities. The fact that these securities have essentially the same credit risk standing as Treasuries makes them particularly useful in the decomposition below. The specific security used is the October 2020 Refcorp bond, of which USD 5 billion were issued. Because the security is estimated to be about 90% stripped, we consider the yield on the principal

2 All Treasury data considered are from a proprietary database collected by the Federal Reserve Bank of New York. Similar data are reported daily in the *Wall Street Journal*.

3 For a more complete discussion of the Treasury market, see Dupont and Sack (1999).

4 The smoothed yield curve is estimated following the method of Fisher et al (1995). It abstracts from the idiosyncratic features that sometimes affect individual securities and controls for the maturity and coupon of each issue. More details are available in Bank for International Settlements (1999).

strip from this security. Overall, the Refcorp strip, with bid-ask spreads of about 1 basis point, is somewhat less liquid than comparable Treasuries but more liquid than most corporate securities.

Among the private interest rates considered, the ***swap rate*** is the fixed rate on a 10-year interest rate swap - that is, the fixed rate one would receive in return for making floating rate payments tied to Libor.[5] Notional amounts of outstanding interest rate swap contracts have grown tremendously in recent years, and market liquidity is generally superior to that of even the most frequently traded corporate bonds. Bid-ask spreads on 10-year swap contracts are typically around 1/2 basis point.

The ***corporate yield*** considered is based on the Merrill Lynch AA corporate bond index. This index is a weighted average of the yields on all outstanding corporate debt securities with AA credit ratings and maturities between seven and 10 years, where the individual securities are weighted by their market capitalisation.[6] In the results following the decomposition, we also consider a BBB corporate yield derived in the same manner. The securities included in these indices must meet minimum requirements on their liquidity. Nevertheless, the liquidity of the corporate bonds included is lower than that of Treasury securities. While information on trading is mostly anecdotal, bid-ask spreads appear to vary considerably across issues and typically range from 1 to 5 basis points. The market depth at those quoted prices is much lower than that for Treasuries, and the trading volume for individual issues is far lighter.

The analysis that follows assumes that the yields on these fixed income assets are influenced by five unobserved factors: the 10-year risk-free interest rate *R*, a liquidity preference factor *L*, a credit risk factor *C*, an idiosyncratic Treasury factor *T*, and an idiosyncratic swap factor *S*. In principle, all of these unobserved factors could influence the five observed market rates. Our identification scheme is designed to make enough assumptions about the manner in which these factors feed through to market rates to be able to capture the underlying factors and the magnitude of their influence. In particular, the factors are assumed to influence the observed market rates as follows:

$$\begin{bmatrix} y^{on} \\ y^{off} \\ y^{r} \\ y^{c} \\ y^{s} \end{bmatrix} = \begin{bmatrix} 1 & -1 & 0 & 1 & 0 \\ 1 & \alpha^{o} & 0 & 1 & 0 \\ 1 & \alpha^{r} & 0 & 0 & 0 \\ 1 & \alpha^{c} & 1 & 0 & 0 \\ 1 & \alpha^{s} & \beta^{s} & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} R \\ L \\ C \\ T \\ S \end{bmatrix} \qquad (1)$$

where y^{on} is the yield for the on-the-run Treasury security, with y^{off} for the off-the-run Treasury, y^{r} for the Refcorp security, y^{c} for the corporate bond and y^{s} for the swap.

A number of restrictions have been placed on the matrix of factor loadings, which in fact define the unobserved factors. The interpretation of the factors in equations (1) is as follows.

(i) The risk-free rate *R* is assumed to affect all yields equally, ie each market rate has a loading of one on that factor. Note that the risk-free rate is not just measured by the Treasury rate, which is also affected by the liquidity factor and the idiosyncratic Treasury factor, but is instead defined by the common movements observed across all market yields.

(ii) The liquidity preference factor *L* is the only factor that affects the spread between on-the-run and off-the-run Treasury securities, as this spread represents a premium that investors are willing to pay for the greater liquidity of on-the-run issues. In interpreting the liquidity factor, we assume that the relative liquidity of on-the-run and off-the-run Treasury securities remained relatively constant over the sample, in which case *L* reflects investors' preferences for liquidity rather than shifts in the amount of liquidity.[7] The influence of the liquidity factor on

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5 The data on swap rates are from Bloomberg. More recent data on swap rates are available from the Federal Reserve's H.15 data release.

6 Since February 2001, we have instead used the 10-year par yield from a smoothed yield curve estimated using the yields of the individual securities contained in the Merrill Lynch index, which allows us to precisely obtain a maturity of 10 years.

7 Of course, the liquidity of these and other securities considered may have shifted over the sample. An analysis of this shift is beyond the scope of this paper.

other market yields is determined by the correlation of movements in those yields with the yield spread between on-the-run and off-the-run Treasury securities.

(iii) The credit risk factor *C* reflects changes in compensation for bearing credit risk, which could reflect shifts both in the perceived amount of credit risk and in investors' willingness to bear credit risk. Note that this factor does not influence the Treasury or Refcorp yields, which have no credit risk. This factor accounts for some of the movements in corporate and swap spreads measured relative to the risk-free rate, although movements in liquidity preferences and idiosyncratic shocks can also affect these spreads.

The final two factors are idiosyncratic shocks to Treasuries *T* and swaps *S*, which are identified because they impact only those particular securities.

(iv) A decrease in the idiosyncratic Treasury factor pushes down Treasury yields relative to all other assets, causing all spreads relative to Treasuries to widen.[8] Note that this shock is distinguished from a credit risk shock because it has an equal impact on all spreads to Treasuries, whereas a credit risk shock has a differential impact according to the credit quality of the asset. The idiosyncratic Treasury factor may reflect any benefits to holding Treasury securities that are not shared by other assets, such as their transparency for balance sheet reporting or their widespread use as collateral in derivatives and repo transactions.

(v) Idiosyncratic swap shocks are identified in a similar manner.

Three of the interest rates included in the exercise - on-the-run Treasury, off-the-run Treasury, and Refcorp security - are free of credit risk, yet they can differ from each other considerably. These differences highlight some important conceptual issues about defining the risk-free interest rate.

According to the decomposition, one reason why the yields of these securities differ is the differences in their levels of liquidity. In fact, because assets are described by both their risk exposures and their liquidity, the risk-free interest rate can only be defined for an assumed level of liquidity. In the results that follow, we define the risk-free rate (the factor *R*) as corresponding to the liquidity level of the off-the-run Treasury security, which is accomplished by imposing the restriction $\alpha^o = 0$.[9]

Even adjusting for liquidity, there is still some difference between the Treasury rates and the risk-free rate, which indicates that some other factor is influencing these yields. In our exercise, we have assumed that this other factor is an idiosyncratic component of Treasury yields.[10] One implication of this assumption is that the risk-free interest rate is not simply given by the return on Treasury securities. Under our decomposition, an investor holding Treasury securities has exposure not just to the risk-free rate, but also to the idiosyncratic Treasury factor. This seems to accord well with recent history: investors holding Treasuries in recent years have clearly been exposed to the risks associated with changes in their supply, as discussed below.

To implement this model, it will be easier to work in terms of deviations from the off-the-run Treasury yield. The system of equations (1), under the restriction that $\alpha^o = 0$, can be rewritten as

$$\begin{bmatrix} y^{on} - y^{off} \\ y^{r} - y^{off} \\ y^{c} - y^{off} \\ y^{s} - y^{off} \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 & 0 \\ \alpha^r & 0 & -1 & 0 \\ \alpha^c & 1 & -1 & 0 \\ \alpha^s & \beta^s & -1 & 1 \end{bmatrix} \cdot \begin{bmatrix} L \\ C \\ T \\ S \end{bmatrix} \qquad (2)$$

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8 Duffee (1996) applies a factor-type analysis to short-term market yields and finds that an idiosyncratic component for Treasury bill rates became more evident beginning in the early 1980s.

9 As a benchmark for pricing other assets, one might want to construct a risk-free rate with the same liquidity loading as the asset being priced. Decomposing market rates into these fundamental factors allows one to do so.

10 We could have alternatively assumed that an idiosyncratic factor influenced agency yields, but our readings of the market are that the Treasury securities have had a much larger idiosyncratic component, which has motivated the structure of our model.

With this form, the risk-free interest rate factor drops out of the model, which reduces the dimension of the problem. Once the parameters and factors of the system of equations (2) are identified, the risk-free rate can be recovered using any of the equations in (1).

Working with the model in terms of deviations from the off-the-run Treasury yield also allows us to make adjustments to account for the fact that none of the securities has a maturity of exactly 10 years. This problem is particularly acute for the Refcorp security, which has a fixed maturity date in 2020. With the model written in terms of spreads, we can alter the off-the-run security used for the various individual securities. In the case of the Refcorp security, we derive a zero coupon Treasury yield with the same maturity date as the Refcorp security using our estimated off-the-run Treasury yield curve, which is then used to calculate the yield spread.[11]

A similar maturity problem arises for the on-the-run Treasury security, albeit on a much smaller scale. The on-the-run security has a maturity of 10 years when it is issued, but that maturity then shrinks over time until the next 10-year security is issued, typically three to six months later. Thus, to obtain an appropriate measure of the spread between on-the-run and off-the-run issues, we use our estimated off-the-run Treasury yield curve to create a "synthetic" off-the-run Treasury security that has the same coupon rate and maturity date as the on-the-run 10-year Treasury note. Again, the yield spread is defined relative to the yield on this synthetic security.

The on-the-run yield spread is also strongly affected by the Treasury auction cycle, in that the liquidity of the on-the-run issue drops considerably once a new on-the-run security is issued. As a result, the on-the-run premium tends to jump at the time of a new auction, when the liquidity services will be enjoyed for the longest time period, and then to gradually decline as the next auction approaches.[12] This pattern became more exaggerated in 2000, when the Treasury moved to a schedule of issuing new 10-year notes every six months rather than quarterly. To control for this pattern, we regress the yield spread between the on-the-run security and the synthetic off-the-run security on the number of days until the next auction. The residual from this regression, once adjusted for the average level of the spread, is taken as our measure of the on-the-run yield spread.[13]

All data are weekly averages of daily rates and cover the period from 6 January 1993 to 5 September 2001. The next section describes the procedure for solving for the parameters and unobserved factors from the above decomposition.

3. Method and results

Our identifying assumptions reduced the number of unknown parameters in the matrix given in equations (2) to four. These remaining parameters can be determined by imposing several additional restrictions that still allow us to be quite flexible in our treatment of the covariances of the underlying factors. In particular, we assume that the idiosyncratic Treasury factor and the idiosyncratic swap factor are orthogonal to all other factors. These restrictions correspond to our general interpretation of the shocks as movements specific to just those particular interest rates. In addition, we assume that the liquidity loading of the agency security equals that of the corporate securities, ie $\alpha^r = \alpha^c$. Both are less liquid than off-the-run Treasury securities, although the Refcorp bond may be somewhat more liquid than most of the corporate bonds included in the Merrill Lynch index. Nevertheless, the assumption is probably not violated too strongly.

These assumptions allow us to solve the model quite easily - indeed, recursively. The restriction on the liquidity loadings provides a direct measure of the credit factor:

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11 Of course, maturity differences will still affect the results if the magnitudes of the factors vary across different maturities.

12 One can also think of this pattern in terms of the repo market. Investors are often willing to earn a below market interest rate when they obtain the on-the-run security as collateral (those issues trade "on special"). The premium on the on-the-run issue incorporates the present value of the specialness of the security, as described by Duffie (1996). As the next auction approaches, the horizon for this specialness shrinks, thus reducing its impact on the yield of the on-the-run issue.

13 Making this adjustment is equivalent to adding a deterministic variable to the system of equations (2).

$C = y^c - y^r$.

Moreover, the liquidity factor is determined by the spread between on-the-run and off-the-run Treasury yields:

$L = y^{off} - y^{on}$.

Plugging this factor into the equation for the Refcorp spread yields:

$(y^r - y^{off}) = \alpha^r \cdot (y^{off} - y^{on}) - T$.

Because we have assumed that the factor *T* is orthogonal to the other factors, this equation can be estimated by an OLS regression, where the estimated coefficient determines α^r. The sum of the constant and the residual from the regression defines the idiosyncratic Treasury factor *T*. Similarly, an equation for the swap spread can be derived as follows:

$(y^s - y^{off}) = \alpha^s \cdot (y^{off} - y^{on}) + \beta^s \cdot (y^c - y^r) - T + S$.

The variable $(y^s - y^{off}) + T$ can therefore be regressed on the variables $(y^{off} - y^{on})$ and $(y^c - y^r)$ to recover the coefficients α^s and β^s, and the sum of the constant and the residual defines the idiosyncratic swap factor *S*.

Applying this approach, we recover all of the factors and coefficients from the system of equations (2).[14] Given those variables, it is straightforward to recover the risk-free rate from any of the equations in (1). Using the equation for the off-the-run Treasury yield, the risk-free rate is

$R = y^{off} - T$,

which indicates that the Treasury yield deviates from the risk-free rate by the idiosyncratic Treasury factor.

The estimated parameters from the decomposition are summarised in Table 1. All of the estimated factor loadings are significant with the expected signs. The estimates indicate that the liquidity factor pushes up agency, corporate and swap yields relative to off-the-run Treasuries, ie αr and αs are positive. The loading on liquidity for swaps is greater than that for agency and corporate securities, which may reflect the fact that the Refcorp security is fairly liquid. The loading on credit risk for the swap is about 58% of that for AA corporate bonds. Thus, the results indicate that swaps do have exposure to credit risk, although much less so than AA corporate bonds.

Table 1
Estimated parameters of the decomposition

Parameter	Coefficient	t-statistic
α^r	0.249	3.08
α^s	0.762	9.42
β^s	0.577	14.74

t-statistics are corrected for heteroskedasticity and serial correlation in the errors.

Swaps may have less exposure to credit risk than AA corporate bonds in part because the investor in a swap is not lending the principal amount to a specific AA firm for the duration of the contract.[15] The

[14] The variance-covariance matrix of the yields in (1) includes 15 observations, and the model has 11 unknown parameters, which leaves four overidentifying restrictions. We do not focus on testing the model using those restrictions but simply note that the restrictions are not strongly violated.

[15] The determinants of swap spreads are discussed by Lang et al (1998).

credit risk component of the swap rate arises from its ties to the Libor rate, which is a short-term borrowing rate paid by firms primarily with AA credit ratings.[16] More specifically, the forward rate on the swap is linked to the rate at which an investor would commit today to lend to a firm that is in the Libor panel in, say, 10 years. But the panel of firms used in determining the Libor rate changes over time, so that firms that fall into financial difficulty could be dropped from the panel. Moreover, even among the banks included in the panel, the four highest and four lowest borrowing rates are excluded in computing Libor, thus removing those firms paying the highest credit spreads. In contrast, the forward rate on the AA corporate bond is the rate at which the investor is willing to commit today to lend to a specific firm in 10 years, which may be a riskier prospect.

With the model solved, one can describe financial market developments in terms of the underlying factors rather than in terms of market interest rates. Note that the matrix multiplying the unobserved factors in equations (1) is invertible, allowing one to express the unobserved factors as linear combinations of the observed market interest rates. The five factors derived from the decomposition are shown in Figure 1. We will describe their behaviour first by going through a chronology of events in US fixed income markets, allowing these factors to help interpret those events, and then by reporting on their statistical properties over the period in the next section.

Policy tightening in 1994. As the Federal Reserve tightened monetary policy beginning in February 1994, market participants continued to mark up the expected path of policy, causing long-term risk-free interest rates to rise considerably. In fact, the risk-free rate accounts for most of the movement in market rates during this period. The credit risk factor widened, perhaps reflecting some concern that the policy tightening might slow the economy too much. However, this widening was modest, suggesting that those concerns were not severe.

Narrowing spreads from 1995 through the first half of 1998. This period was characterised by the remarkable stability of the economy and of monetary policy. The federal funds rate was reduced in three steps by a cumulative 75 basis points over six months beginning in July 1995, but was then adjusted only once over the subsequent two and a half years. The economy grew at a steady and robust pace over this period, and inflation gradually declined. The impressive growth of the economy and the benign inflation environment appeared to depress various risk spreads in fixed income markets. Long-term risk-free interest rates declined steadily over this period, perhaps reflecting a decline in the interest rate risk premium. Credit spreads also narrowed somewhat, reaching a trough in late 1997. The liquidity factor remained relatively steady at a fairly narrow level, as did the idiosyncratic Treasury and swap factors.

Flight to quality in 1998. The relative stability of the economy and financial markets changed suddenly in autumn 1998. The events of that time are widely known and have been generally described as a flight to quality.[17] In terms of our model, the events involved a sharp increase in both the liquidity preference factor and the credit risk factor. The increased liquidity preference explains the large spreads between on-the-run and off-the-run Treasury securities observed at that time, while increased concern about credit risk generated the strong tiering of yield spreads across credit quality in corporate and agency bond markets. The model above imposes no restrictions on the covariance between the credit risk and liquidity factors, and in fact they are significantly positively correlated: When investors become more concerned about credit quality, they also generally prefer more liquid assets. The developments in autumn 1998 were an outsized example of this behaviour.

Policy tightening in 1999 and early 2000. The US economy navigated through the financial market disruptions of autumn 1998 without major problems, and by early 1999 economic growth was clearly outstripping the economy's potential to produce. In response, the Federal Reserve began to tighten monetary policy in May 1999 and continued to do so in a string of six policy moves through May 2000. The policy tightenings implemented and the expectations of more to come pushed up the risk-free interest rate substantially - by nearly as much as in the 1994 tightening episode, even though the cumulative rise in the funds rate was much smaller. The credit risk factor and the liquidity preference

[16] The Libor rate is computed by the British Bankers' Association as the trimmed average of the eurodollar deposit rate offered by a panel of 16 banks. See www.bba.org.uk for more details.

[17] The events of autumn 1998 are reviewed in detail in a report by the Committee on the Global Financial System (1999) published by the Bank for International Settlements.

factor both remained at levels well above those observed over the previous few years, and the credit risk factor began to widen more in early 2000.

Widening spreads in 2000. By mid-2000, US economic growth began to moderate from its rapid earlier pace. The long-term risk-free rate declined from its peak in the spring of 2000, as market participants gradually altered their expectations that policy would continue to tighten. The slowing economy and falling stock prices contributed to a considerable rise in the credit risk factor over this period, while the liquidity preference factor narrowed. The idiosyncratic Treasury factor, which had barely budged since 1993, fell sharply in early 2000, moving about 30 basis points lower by April of that year. This movement probably reflects the concerns about the potential scarcity of Treasury securities that emerged at that time, which may have resulted in a sizeable premium on Treasury securities, as discussed in much more detail in the next section.

Sizeable policy easing in 2001. Towards the end of 2000, it became increasingly apparent that the economy was slowing more abruptly than had been expected. Long-term risk-free rates began to decline sharply in November 2000 in anticipation of monetary policy easing. In the event, the Federal Reserve eased policy quickly and by sizeable amounts beginning in January 2001, lowering the federal funds rate by 3 percentage points by early September. Having fallen ahead of the policy actions, the risk-free rate fluctuated in a narrower range after the easings began as market participants assessed the extent of the slowdown and the prospects for a pickup in economic growth. The credit risk factor narrowed somewhat once the easings began, while the Treasury and liquidity factors held relatively steady. Interestingly, the idiosyncratic swap factor became much larger in 2001.

4. The shifting behaviour of market interest rates

The decomposition offered in the previous section allows policymakers and market participants to focus on the fundamental factors that determine movements in market interest rates. But this narrative also suggests that the relative importance of the factors shifts over time. Indeed, our results indicate that a number of factors have become larger and more volatile in recent years. Table 2 shows the average levels and weekly changes of all the factors, dividing the sample into three subperiods to highlight the behaviour of the factors in recent years. Shifts in the size or volatility of various factors are indicated by the bold entries in the table.

Table 2
Recent behaviour of the factors
(basis points)

	1993:1 to 1998:2	1998:3 to 1999:4	2000:1 to 2001:3
Average levels			
Risk-free rate	660	577	613
Credit risk	31	**51**	**90**
Liquidity	11	**28**	**16**
Idiosyncratic Treasury	– 10	– 9	**– 28**
Idiosyncratic swap	– 10	– 7	– 9
Average weekly changes			
Risk-free rate	8.0	8.6	7.5
Credit risk	1.6	**2.5**	**3.1**
Liquidity	1.0	**1.9**	**1.3**
Idiosyncratic Treasury	0.9	0.7	**1.3**
Idiosyncratic swap	1.3	**3.3**	**2.9**

The shifts in the behaviour of the underlying factors have numerous implications for the information content of market interest rates. Here we focus on two broad conclusions that might be particularly relevant to monetary policymakers.

(i) Treasury yields have become increasingly divorced from the risk-free rate

Over much of the sample, the yield on the off-the-run Treasury security provided an effective measure of the 10-year risk-free interest rate. According to equation (1), the Treasury yield deviates from the risk-free rate by the idiosyncratic Treasury factor. This factor was remarkably flat from 1993 through 1999, leaving the Treasury rate below the risk-free rate by a nearly constant amount, as is apparent from Figure 2.[18] However, as pointed out above and shown in Table 2, the idiosyncratic Treasury premium has become much larger since 2000, pushing the Treasury rate down relative to other market interest rates and increasing the wedge between the Treasury yield and the risk-free interest rate.[19]

The decline in Treasury yields relative to all other market yields in early 2000 may have resulted from a "scarcity premium" on Treasury securities. Indeed, the publication in early 2000 of the CBO's forecasts for sizeable surpluses over the coming decade and the Treasury's implementation of a debt buyback programme and other debt management decisions seemed to focus the market's attention on the possibility that the Treasury would pay down a considerable amount of its outstanding debt over the coming decade. Concerns that Treasury securities would become increasingly scarce appeared to have a considerable impact on the yields of those securities, particularly at longer maturities where fewer safe and liquid substitutes are available.

These developments can be characterised using a simple diagram depicting overall supply and demand conditions for longer-term Treasuries as in Figure 3, which is repeated from Reinhart and Sack (2000). Traditional finance models, such as the capital asset pricing model (CAPM), suggest that premiums for holding Treasury securities relative to other fixed income assets should be quite small and that the demand for Treasuries should be very sensitive to interest rates. In that case, even large changes in the supply of Treasury securities would have only small consequences for Treasury yields, and thus concerns about supply could not account for the sizeable movement in the idiosyncratic Treasury factor.

The recent movements in relative yields instead suggest that the demand schedule for Treasury securities is everywhere well below the CAPM curve and becomes very inelastic at lower levels of supply, as shown in the figure. The relatively low level of the demand curve reflects the value that investors place on the liquidity of Treasuries, a characteristic not captured in the CAPM model. And the demand schedule probably contains an inelastic portion at lower quantities because of the heterogeneity of investors. In particular, there are some types of investors who place very high value on the safety and liquidity of Treasury securities.[20]

Under this demand schedule, large shifts in the supply of Treasury securities could have important consequences for the pricing of those securities, as the shrinking supply of Treasuries would increasingly be held by those investors willing to sacrifice the most yield to hold them. Of course, actual supply did not suddenly drop to the inelastic portion in early 2000. But the prospect that supply might reach that region within a couple of years, along with the forward-looking behaviour of markets, may have had a substantial impact on current longer-maturity Treasury yields. Investors also faced considerable uncertainty about the speed and magnitude of the paydown in Treasuries and about the

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18 Because there is no idiosyncratic factor affecting the Refcorp yield, any portion of the spread between the Refcorp and the off-the-run Treasury yields not explained by liquidity must be attributed to the Treasury factor, which pushes it away from the risk-free interest rate by this constant amount. However, the more interesting focus of the model is on the movements in the factors, not on the constant terms.

19 A research report by Lehman Brothers (see Kocic et al (2000)) reaches a similar conclusion using a different methodology. They assume that the risk-free rate is a random walk and apply a Kalman filter approach, controlling for liquidity and credit risk in a manner similar to ours.

20 Included in that set are probably foreign official institutions, which might be very concerned about avoiding losses on their portfolio and about being able to liquidate positions quickly.

shape of the demand schedule in that region, which may have made the idiosyncratic Treasury factor more volatile as well.

The larger idiosyncratic premium on Treasury securities raises the question of whether some other asset could serve as a better proxy for the risk-free interest rate. Indeed, there has been considerable discussion about a possible transition to interest rate swaps as a "benchmark" for the pricing and hedging of other fixed income assets. Our results indicate that swaps do not represent a benchmark for the risk-free rate, but instead one that has less credit risk than most corporate bonds.[21] Indeed, as shown in Figure 2, the swap rate has deviated from the risk-free rate by more than the Treasury rate in recent years, reflecting the impact of the credit risk and liquidity factors.

Of course, the fact that swaps have some credit risk may be an important advantage to becoming a benchmark for the pricing and hedging of private instruments. Much of the discontent with Treasuries as a hedging instrument began in autumn 1998, when the flight to quality discussed above pushed down Treasury yields and pushed up lower-rated corporate yields. Unlike Treasuries, swaps have exposure to both the credit risk and liquidity preference factors, the two factors influenced by the flight to quality, which makes them more comparable to corporate bonds. Thus, swaps would have provided a better hedge for corporate bonds during that period.

Nevertheless, swaps appear to also have a significant idiosyncratic factor that reduces their effectiveness as a hedging instrument, and that component became larger in 2001 (see Figure 1). It is not clear at this point why the swap rate became more idiosyncratic in 2001. One conjecture is that this pattern reflects the increased use of swaps as hedging instruments, which may cause their rates to be influenced by the amount of corporate bond issuance or prepayment risk on mortgage-backed securities. In addition, the government-sponsored enterprises (GSEs) have reportedly been very active in the swaps market in recent years. Changes in their behaviour or strategies could introduce variation in swap rates that would be viewed as idiosyncratic in this model.[22]

(ii) Spreads between various yields have been increasingly influenced by a number of different factors

Spreads between various yields have become harder to interpret in recent years because they have been increasingly influenced by a number of different factors. Of course, the impact of those factors on any given spread will depend on the factor loadings of the securities involved. Above, we identified the loadings for five different assets. But if the factors identified truly represent fundamental influences on asset prices such as liquidity preference, credit risk and risk tolerance, then one would expect them to have some influence on the prices of a wider range of financial assets. In particular, it may be interesting to look at the behaviour of corporate bonds with lower credit ratings, such as the Merrill Lynch BBB corporate bond index.

We can measure the factor loadings of BBB corporate bonds simply by regressing the BBB yield on our factor measures. In doing so, we impose that its loading on the risk-free rate is one and its loadings on the idiosyncratic Treasury and swap factors are zero. Under those assumptions, the regression indicates that the BBB yield responds significantly to the liquidity and credit risk factors, with loadings of 1.82 and 1.48 respectively. Note that the lower-rated corporate yield has a significantly higher loading on both the liquidity factor and the credit factor in comparison to the AA yield (which has loadings of 0.25 and 1.00 respectively) and the swap rate (0.76 and 0.58 respectively). The higher loading on the liquidity factor is consistent with the fact that lower-rated bonds are generally less liquid than many higher-rated issues.

Figure 4 shows the resulting factor decompositions for the AA and BBB corporate yield spreads measured relative to on-the-run Treasury securities, which is still the most common quoting convention. The average levels of these yield spreads and the various components are detailed in Table 3. For both the AA and BBB corporate bonds, the credit risk factor accounted for a sizeable

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21 Conversely, Kocic et al (2000) argue that swaps have become a better proxy for the risk-free rate than Treasuries.

22 If we regress the yield on the 10-year Fannie Mae benchmark security since 1998 (the beginning of that programme) on the five factors, we find that the swap factor enters with a strongly significant coefficient. This supports the notion that there is some linkage between the swap factor and the behaviour of the GSEs.

portion of the average yield spreads from 1993 through the first half of 1998, although the liquidity factor and the Treasury factor also importantly contributed to the spreads.

Both corporate yield spreads jumped higher over the period from the second half of 1998 through 1999, but that widening cannot be attributed entirely to credit risk. In each case the heightened preference for liquidity contributed at least as much to the widening of the spread as did the increase in credit risk. Over the period beginning in 2000, both yield spreads again increased sharply. According to the results, the credit risk factor accounted for most of the increase in spreads. But the increase in the idiosyncratic Treasury factor at that time contributed about 20 basis points to the average spread widening. Overall, these results emphasise the importance of considering factors other than credit risk for interpreting corporate yield spreads, as both liquidity and Treasury-specific factors have strongly influenced yield spread movements in recent years.

Table 3

Average level of corporate yield spreads

(basis points)

	1993:1 to 1998:2	1998:3 to 1999:4	2000:1 to 2001:3
AAA yield spread			
Total spread	54.7	94.5	138.2
Due to:			
Credit risk	31.2	51.3	90.1
Liquidity	13.7	34.5	20.3
Idiosyncratic Treasury	9.8	8.7	27.7
BBB yield spread			
Total spread	103.5	186.3	222.6
Due to:			
Credit risk	46.3	76.0	133.6
Liquidity	31.0	78.0	45.9
Idiosyncratic Treasury	9.8	8.7	27.7

Spreads are measured relative to on-the-run Treasury securities. For the BBB yield spread, the components do not add up to the total spread because of the constant and the residuals from the regression.

Another interesting development in US fixed income markets in recent years has been a striking increase in the volatility of the yield spreads between various US fixed income securities, as shown in Figure 5. Table 4 provides some details on this behaviour for both corporate and swap yield spreads. The volatilities of these yield spreads jumped in the more recent subperiods to several times their earlier levels, even though the volatilities of the rates themselves changed only modestly. The factor decomposition offers some explanation of these patterns. The volatility of the risk-free rate - the common component of all yields - did not change much (see Table 2), thus keeping the volatilities of all of the market interest rates relatively steady. However, the volatilities of other factors became elevated in the more recent periods, resulting in the greater variation in yield spreads. The liquidity factor was particularly volatile in the 1998-99 subperiod, while the idiosyncratic Treasury factor was more volatile over the period beginning in 2000. In addition, both the credit risk factor and the idiosyncratic swap factor were very volatile during both of the more recent periods.

The fact that numerous factors were at work can explain the breadth of the increase in volatility across different instruments. Looking down the left-hand side of Figure 5, the volatilities of all spreads relative to the on-the-run Treasury yield (the ones included in Table 4) increased considerably, reflecting the greater variation in the idiosyncratic Treasury factor, the liquidity factor and the credit risk factor. The right-hand side of the figure more closely isolates the contributions of individual factors. Notable increases are observed in the volatility of the spread between the on-the-run and off-the-run Treasury yields, reflecting the liquidity factor, and in that of the spread between the Refcorp and off-the-run Treasury yields, largely reflecting the idiosyncratic Treasury factor. Lastly, even spreads between the yields of corporate bonds with different credit standings became more variable, reflecting greater variation in both liquidity preference and credit risk.

Table 4
Average absolute value of weekly changes
(basis points)

	1993:1 to 1998:2	1998:3 to 1999:4	2000:1 to 2001:3
Yields			
On-the-run Treasury	8.2	8.8	8.0
Swap	8.2	8.7	8.0
AA corp	7.8	8.8	7.0
BBB corp	7.8	8.7	7.8
Spreads			
AA - Treasury	1.2	2.9	3.0
BBB - Treasury	1.4	3.4	3.8
Swap - Treasury	0.9	2.9	3.4

Spreads are measured relative to on-the-run Treasury securities.

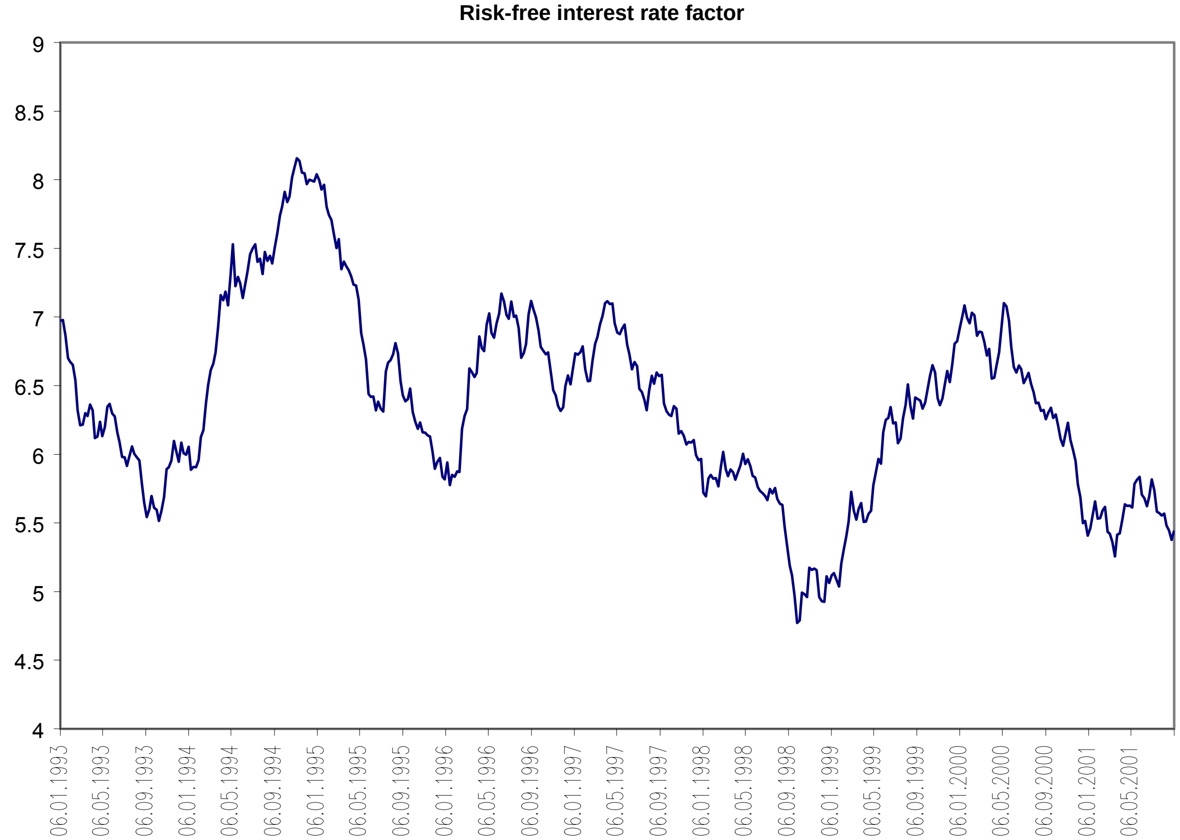
5. Conclusions

Overall, this paper suggests that it is more informative to focus on movements in the fundamental factors influencing market interest rates than on the market rates themselves. This paper offers a decomposition of market interest rates into five fundamental factors based on the co-movements of the yields on different types of US fixed income assets. Those factors offer a sharper interpretation of market events since 1993, thus providing policymakers with useful information for formulating appropriate policy decisions. Similarly, market participants would also benefit from understanding the fundamental factors driving movements in fixed income prices, which would allow them to more accurately assess the risks and potential rewards associated with their investment and hedging strategies.

In addition, the analysis suggests that significant shifts in the importance of the underlying factors have taken place in recent years, with important consequences for interpreting market interest rates. The increased variation of a number of different types of shocks in recent years has made it more difficult to derive information from individual market rates or spreads. Two examples were highlighted in the paper: Treasury yields have become increasingly separated from the risk-free interest rate, and corporate yield spreads have been increasingly influenced by shocks other than credit risk. As a consequence, policymakers should rely more heavily on using the co-movements in yields across a number of different securities to effectively identify movements in the fundamental factors that drive the markets.

Figure 1

Unobserved factors



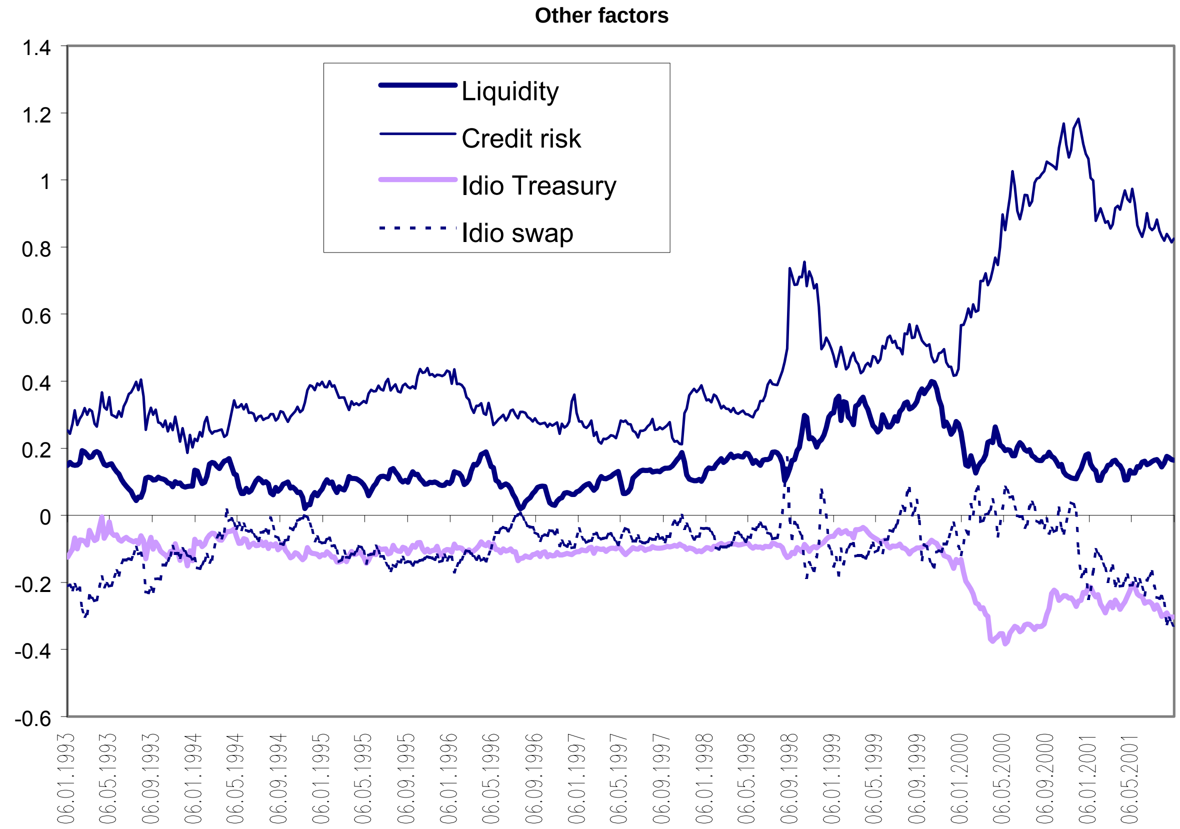


Figure 2

Measures of the risk-free interest rate

Levels of measures

Deviations

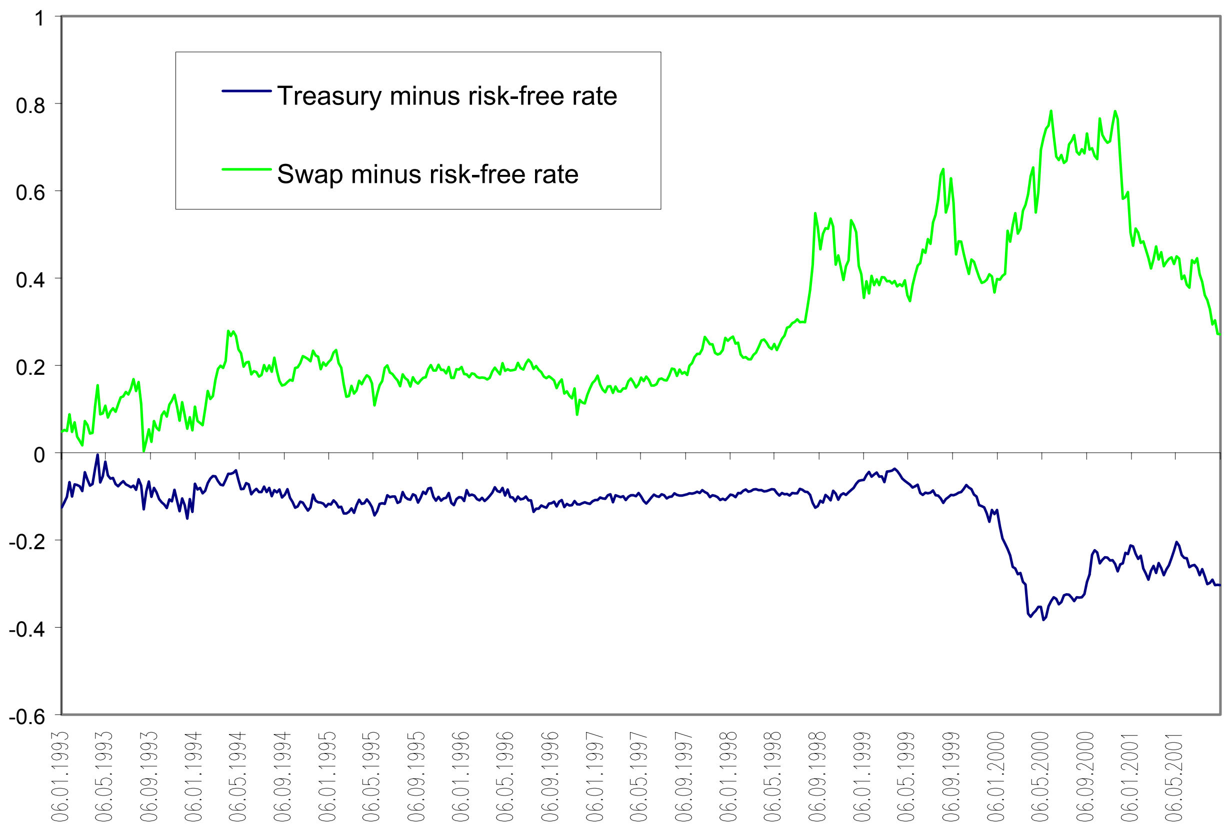


Figure 3
Demand and supply for Treasury securities

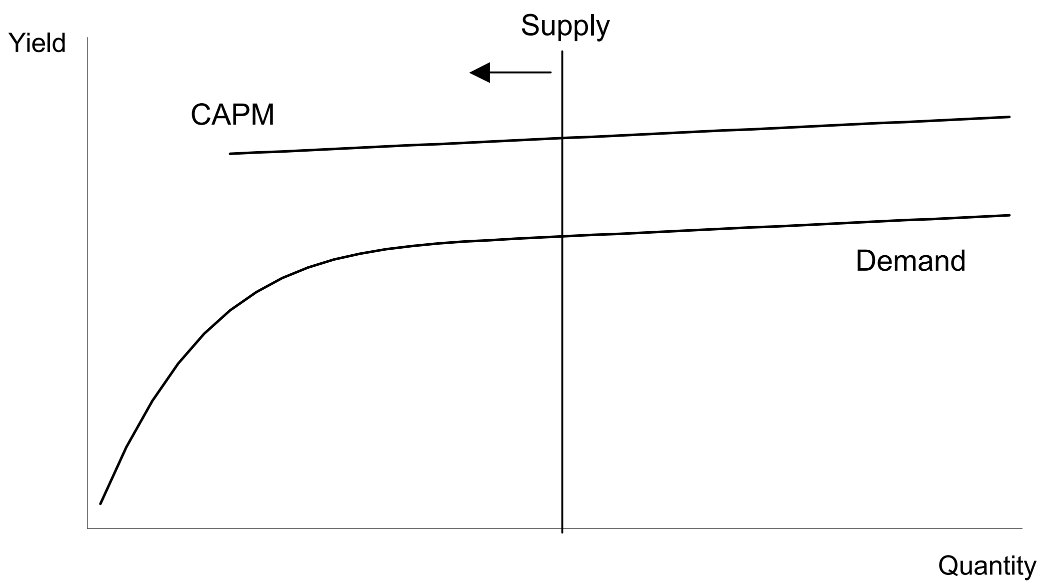
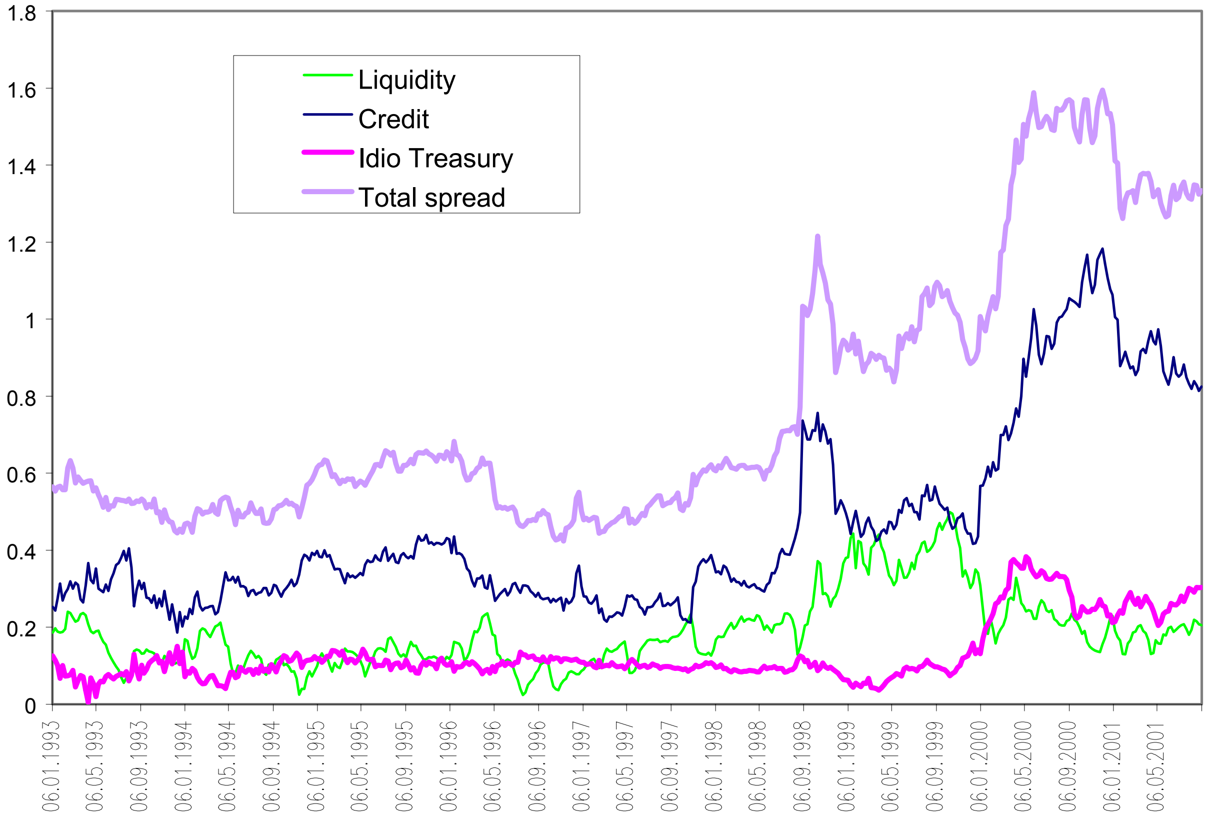


Figure 4

Corporate yield spreads and components

AA spread over on-the-run Treasury



BBB spread over on-the-run Treasury

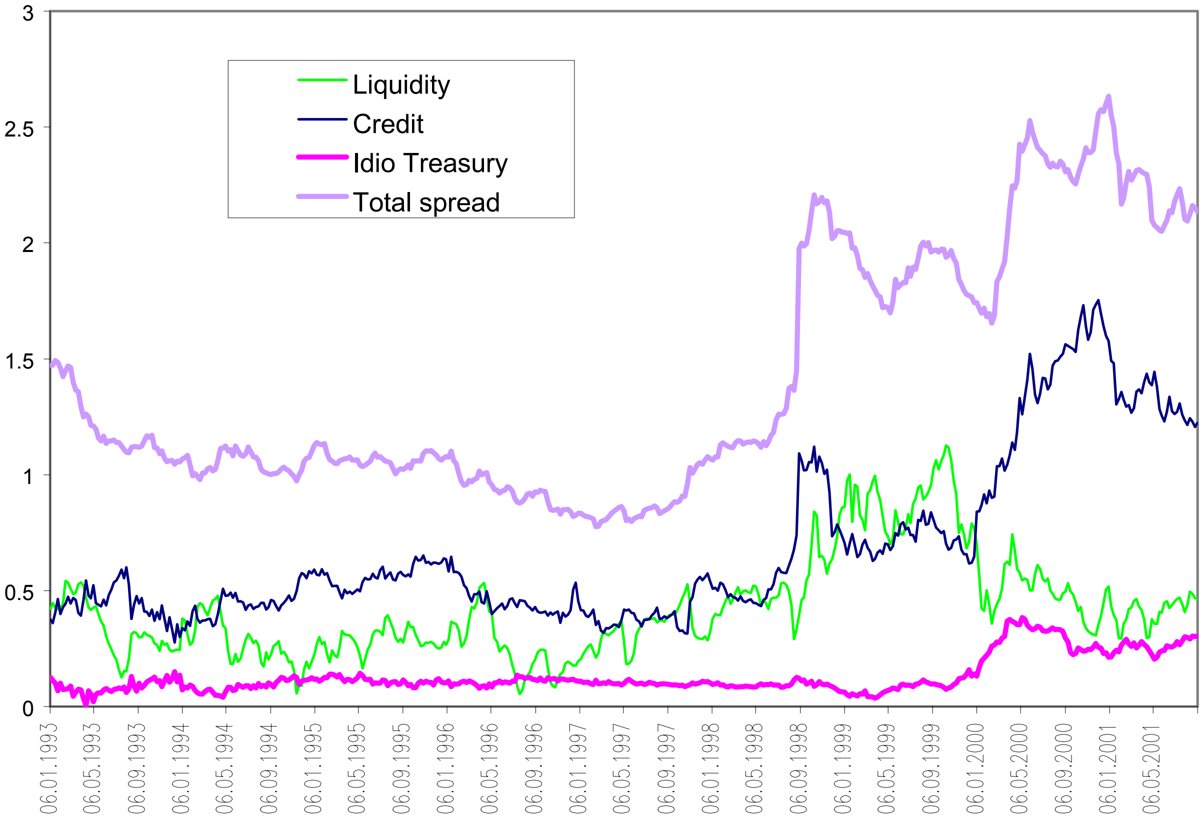
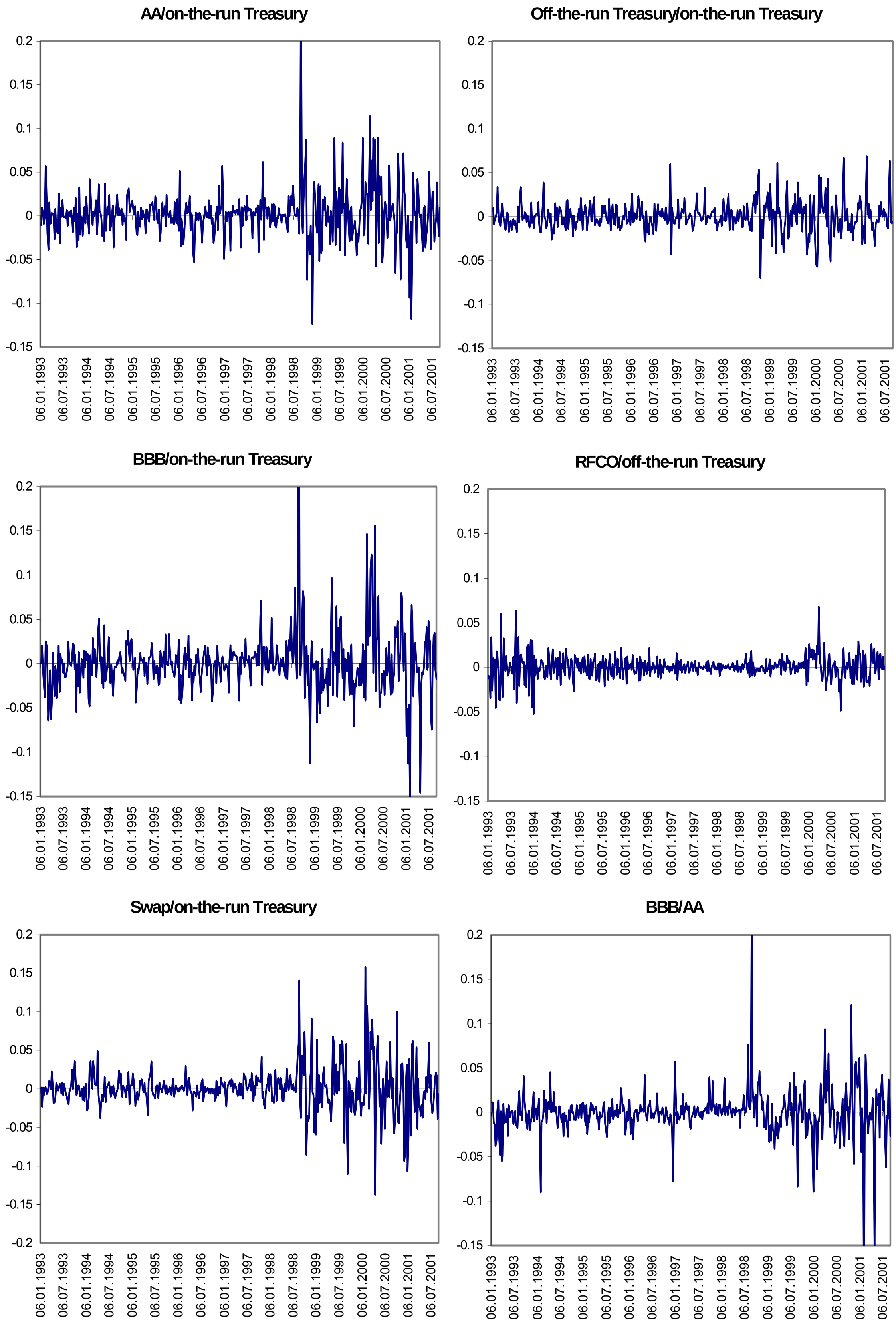


Figure 5
Weekly changes in yield spreads



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