A Global Liquidity Factor for Fixed Income Pricing

Andreas Gintschel[‡]
J.P. Morgan

Christian Wiehenkamp[*]
Goethe University Frankfurt

[‡] J.P. Morgan Chase Bank, Junghofstr. 14, 60311 Franfurt am Main, Germany. Email: andreas.c.gintschel@jpmorgan.com, Phone: +49 69 71242195, Fax: +49 69 71241365

[*] Corresponding author; Ph.D. cand. in Finance and Monetary Economics, House of Finance, Goethe University Frankfurt, Campus Westend - Grüneburgplatz 1, 60323 Franfurt am Main, Germany. Email: wiehenkamp@finance.uni-frankfurt.de, Phone: +49 177 5803534
Part of this research was conducted while the corresponding author visited the Stern School of Business at NYU. The authors are grateful to Viral Acharya, Yakov Amihud, Georges Dionne, Holger Kraft, Christian Schlag, and Monika Trapp, as well as participants at the 2009 Bowles Symposium, Atlanta, the 2009 Society for Financial Markets Conference in Geneva and Seminar participants at Goethe University, for helpful comments and suggestions. Responsibility for the contents of the paper rests solely with the authors and should not be attributed to J.P. Morgan or any of its affiliates.

A Global Liquidity Factor for Fixed Income Pricing

Version: May 26, 2009

Abstract

Liquidity premiums have been widely documented in equity markets. However, empirical evidence for systematic liquidity in fixed income instruments, which are typically far less liquid, is limited. We show that a simple liquidity factor - based on the difference between corporate bond spreads and credit default swaps - is significantly associated with returns in a wide range of fixed income markets. The corresponding liquidity premium is time-varying but persistent and drives a fair amount of serial and cross-sectional variation in fixed income prices. Moreover, liquidity exposure varies predictably with maturity and credit rating suggesting a flight-to-quality phenomenon.

KEYWORDS: Liquidity, Bond Market, Asset pricing, Factor Models

JEL CLASSIFICATION: G12, G15, G21

1 Introduction

The recent turmoil in financial markets has dramatically highlighted the importance of liquidity. For weeks interbank lending markets and swap markets, the backbones of modern banks' liquidity and interest rate risk management, have been completely frozen. Only unprecedented, massive provision of liquidity by central banks and government guarantees have started to ease the gridlock.

There is also a growing literature modeling liquidity and predicting its effects. Generally, illiquid assets earn a return premium over relatively liquid assets. Whilst liquidity premiums have been widely documented for equity markets, the empirical evidence for systematic liquidity in bond markets remains limited.

In this paper, we proxy the liquidity component of fixed income prices by employing a simple, observable measure for the price of liquidity. We start by decomposing the yield spread of corporate bonds over government bonds into two components: a default component and a liquidity component. For certain bonds, the default component is immediately observable in the form of the spreads quoted for credit default swaps (CDS). Thus, we are able to identify the liquidity component following Longstaff et al. (2005) . We then postulate that liquidity is a global pricing factor in the sense that a change in the price of liquidity affects all assets albeit at varying degrees; i.e. the liquidity factor backed out from selected series contains systematic information about the bond market's liquidity and, thus, significantly relates to other bond returns. The main contribution of the paper is providing empirical evidence for this: Changes in the observable liquidity component of certain bonds have statistically and economically significant effects on the prices of other fixed income instruments. This systematic liquidity factor is fairly stable, but time-varying. We show further that the liquidity component of prices increases with maturity and decreases in credit quality.

Our findings offer interesting time-series evidence for some recent theoretical liquidity-based pricing models and provide additional empirical facts on the cross-section of liquidity risk exposure of assets. The results are also important for the financial industry as they provide a sound empirical basis for incorporating liquidity risk and liquidity premiums into pricing tools, risk management methods and investment strategy.

In the course of the financial crisis, accounting standard setters and financial markets' regulators have begun to emphasize the need to adjust market value for liquidity effects.[1] They argue that, when prices or quotes from thin or inactive markets do not reflect fair value, fair value estimates should be based on non-market inputs ("level 3 inputs") in a DCF calculation. Our results show that there is a simple and reliable way of calculating the liquidity discount for a particular asset. Thus, an alternative estimate of fair value may be calculated by adding back the liquidity discount to a "fire-sale" market price. This may be a more reliable and transparent approach than discounting expected cash flows at risk-adjusted discount rates, both of which are notoriously difficult to estimate. At least, the alternative estimate may serve as robustness check to the DCF method.

Similarly, decomposing the spread of a fixed income asset is helpful in estimating the expected return for the asset, which is crucial for asset allocation decisions of market participants. A natural decomposition of the spread comprises three parts: a component reflecting the expected credit losses (= default probability times expected loss in default), a component reflecting the price discount associated with default risk, and a component reflecting the compensation for illiquidity of the asset. Obviously, the first two components reflect very different risks from the third. In particular, an investor willing and able to hold the asset to maturity can be certain of capturing the liquidity premium at no additional risk (in addition to default risk!).

Finally, our analysis can be used as the basis for new liquidity risk measurement

[1] See `http://www.sec.gov/news/press/2008/2008-234.htm` and `http://www.iasb.org/News/Press+Releases/IASB+publishes+educational+guidance+on+the+application+of+fair+value+measurement+when+markets+become.htm`

methods. For lack of alternatives, current liquidity risk measures are based on cash flow maturities and qualitative assessment of assets' eligibility for secured funding (e.g., Principle 5 of the BIS' Principles for Sound Liquidity Risk Management and Supervision[2], Sept. 2008). Clearly, using market-implied measures of liquidity would probably increase the precision of and provide sound theoretical underpinnings to the liquidity risk estimates. Such market measures of liquidity could be built along the factor model approach familiar from market risk models.

There is a substantial body of literature dealing with liquidity effects in asset pricing surveyed in, e.g., Amihud et al. (2005). However, most of the work on systematic risk focuses on equity markets.[3] In their seminal paper, Amihud and Mendelson (1986) present a theoretical model of and empirical evidence for the price effect of liquidity based on bid-ask spreads. Corresponding empirical work in Amihud (2002) or Pastor and Stambaugh (2003) documents a significant effect of liquidity on expected returns for US equities. Their measure of liquidity is the price elasticity with respect to trading volume. Combining various measures, Korajczyk and Sadka (2008) show that a latent liquidity factor estimated by principal component analysis is relevant for pricing.

For fixed income markets, there are basically three approaches in the literature. The first documents liquidity-induced price effects for issues with identical credit risk, but different liquidities, e.g. between on- and off-the-run US treasuries (Amihud and Mendelson, 1991) or Refcorp bonds (Longstaff, 2004). The samples are typically restricted to very select issuers and the results show only economically small price effects.

The second strand of literature aims at explaining returns (or equivalently, the

[2] Further, Principle 4 states that "A bank should incorporate liquidity costs [...] in the internal pricing [...] for all significant business activities [...]". Clearly, a suitable estimate of these costs would be based on the same insights. In fact, we find it difficult to think of any alternative estimation technique other than plain guessing.

[3] Amihud et al. (2005) devote 26 pages to reviewing approx. 50 papers on equities and 10 pages to about 10 papers on fixed income.

credit spread) of large panels of corporate bonds. For example, Collin-Dufresne et al. (2001) investigate credit spread changes in a structural credit model that fails to explain sufficient variation in spreads by credit risk alone. Similarly, Huang and Huang (2003) using a simulation approach find that corporate spreads are too wide to be explained by credit risk alone. Elton et al. (2001) and Longstaff et al. (2005) corroborate these results by comparing model and empirical spreads. Relying on CDS spreads to control for pure credit risk, Longstaff et al. (2005) can attribute a large part of the non-default component to typical market microstructure measures of liquidity such as the bid-offer spread. Since the spread is just a monotone transformation of price, they identify immediately a return premium due to liquidity risk. The non-default component of corporate spreads, backed out using CDS spreads, is the basis for our analysis. Our interpretation of the non-default component as liquidity is based on Longstaff et al. (2005) results.

The third strand takes an asset pricing approach and investigests factor prices. De Jong and Driessen (2005) show that excess spreads on bonds are linked to Ahmihud's (2002) volume-based liquidity measures.[4] Recently bond market illiquidity has also been documented by Jankowitsch et al. (2008) and Bao et al. (2008) who develop transaction-based liquidity measures, by Edwards et al. (2007) based on transaction costs, or by Goldstein et al. (2007) investigating market transparency. Fama and French (1993) use two risk factors (term premium and default premium) to explain corporate bond returns. Chen et al. (2007) extend that by including Lesmond et al. (1999)'s transaction cost measure, which has significant effect. Similary, Downing et al. (2005) find liquidity risk to be priced in an APT context. Finally, Mahanti et al. (2008) and Mahanti et al. (2007) show that a latent factor related to asset accessibility by investors is also relevant to pricing.

Our contribution to this literature lies in showing that an easily observable liq-

[4] Some authors, e.g. Collin-Dufresne et al. (2002), also try to explain the corporate spread puzzle by means of jump risk premiums.

uidity proxy - based on the idea and results of Longstaff et al. (2005) - is helpful in explaining the returns on a wide range of fixed income portfolios. Thus, we document a systematic price effect of liquidity pervading all fixed income markets that can be captured by a single global risk factor. In contrast, previous research has focussed on documenting effects for individual bonds in subsets of the market. Further we provide strong empirical evidence for liquidity effects in markets previously not analysed. Finally, our liquidity factor is a methodoligical advance by virtue of its simplicity and explanatory power.

The remainder of the paper is organized as follows. First, we elaborate on the difference between spreads and CDS levels of a particular portfolio as a proxy for the liquidity premium and present a simple factor model in section 2. We then test whether the proxy has reasonable and significant loadings in a time-series model of returns for a variety of assets. Put simply, we want to show that the proxy is indeed a valid factor that can price fixed income assets. The results of this analysis and the description of the data are contained in section 3. To corroborate the findings, we perform numerous robustness checks using different liquidity proxies which are reported in 4. Section 5 analyzes the effect of bond maturity and rating on the liquidity exposure. Concluding remarks are offered in section 6.

2 Liquidity & Asset Pricing

Defining a liquidity premium requires a benchmark of a perfectly or most liquid asset. It appears that assets are liquid to varying degrees, and some are almost as liquid as cash in terms of being able to acquire and sell them quickly. For example, the enormous depth and institutional set-up of stock exchanges render many equity securities very liquid. Another, almost perfectly liquid asset is a government bond, since central banks typically accept government bonds as collateral at their repo-windows or as a substitute for minimum deposits. Thus, while a particular government bond might not be particularly liquid – easy to buy or sell – by itself, the central bank's acceptance as first-rate collateral for cheap cash lending renders it near-cash equivalent from a liquidity perspective.[5] This implies a difference between maturity and liquidity. Despite being of long maturity, an asset may still be very liquid – either because of secondary markets or an exogenous liquidity provider (the central bank as the "liquidity provider of last resort"). Table 1 shows the haircuts[6] which the ECB applies to the different types of collateral and confirms the superiority of government bonds in terms of liquidity. Sovereign bonds have relatively low haircuts (for example, 2.5% for a 5 year bond). Corporate bonds, on the other hand, carry approximately double the haircut of government bonds (e.g. 4.5% on a 5 year corporate). Also note that haircuts are increasing in maturity.

Table 1 about here

We use sovereign bonds as the reference for measuring liquidity, following convention in the literature. Holding government bonds, such as US Treasuries, Gilts, Bunds, etc, carries hardly any liquidity premium[7] and no default premium. Thus, the yield on the bond is purely a compensation for the nominal time-value of money. On the other hand, the yield on a corporate bond represents at least three compensation payments: for the time value of money[8], for default risk, and for illiquidity.[9] We, thus, investigate illiquidity as the potential price discount that is *not* due to changing

[5] In addition, interbank repo markets typically work on the same counterparty rules as the central banks.

[6] A haircut is the percentage by which an asset's value is reduced for the purpose of calculating collateral levels. Fed haircut rules are generally similar. Moreover, haircuts in interbank repos are typically modelled after central bank schedules

[7] See the evidence on on- and off-the-run treasuries.

[8] Compensation for time value of money includes compensation for inflation as well as a return for foregoing consumption today.

[9] Elton et al. (2001) also identify a tax component, which we ignore in the current analysis. In a setting dealing with international markets and the dominance of institutional investors that are mostly tax-empt, this should be innocuous.

riskless interest rates or default risk. We do not, however, analyze the sources of illiquidity such as asymmetric information, capacity constraints induced by regulation or capital constraints, etc. An example of research along these lines can be found in Brunnermeier and Pedersen (2007).

The basic variable for measuring the liquidity premium is the corporate bond spread, i.e. the difference between the par yield on a particular fixed-rate corporate bond and the par yield of a corresponding fixed-rate government bond [10] that matches the currency and the maturity of the bond. We use par yields as they are more widely available than zero yields. Since perfectly matching maturities are rarely available, the spreads are usually calculated based on interpolated yields. With the two bonds being matched on maturity, the spread reflects only two components: a default component and a residual component that we interpret as reflecting mostly a liquidity premium, based on Longstaff et al. (2005).

For a range of issuers, there are active markets for credit default swaps (CDS), which essentially are insurance ("protection") against the default of a particular reference bond of that issuer.[11] In a credit default swap, the buyer of protection pays a fixed premium (the CDS spread) and receives a compensation payment in case of a "credit event", typically a (potentially only technical) default of the reference bond. The compensation payment is usually the difference between the par value and the market value of the reference bond. Thus, the CDS insures the holder against the loss due to default of a particular reference bond. Consequently, the fair price of the CDS must reflect the expected loss due to a default and a risk premium for the default risk. With losses of other debt of an issuer being comparable - unless there are differences in the seniority of the debt - a particular CDS can be used as protection against default in any debt issue as long as the maturity of the CDS and the bond are similar.

[10] In line with market convention, EUR issues' spreads are calculated relative to Bunds.

[11] Duffie and Singleton (2003) contain a detailed description of CDS contracts and their markets.

A portfolio consisting of a CDS and the corresponding reference bond with matching notional is essentially a position with no default risk – assuming no counterparty risk on the CDS[12] – for the remaining maturity of the position. In other words, the portfolio is equivalent to a government bond in terms of default risk, and, therefore, in some sense a "synthetic" government bond position. Similarly, we could construct a "synthetic" corporate bond by incurring a long position in the government bond and "selling protection" in the CDS market (Duffie, 1999).

However, the liquidity of the synthetic position is different from the liquidity of the cash bond. For example, the central banks simply do not accept the synthetic position as substitute collateral for the government bond at the repo window. Table 1 shows these for the ECB. Hence, the actual government bond is, independent of its maturity, near-cash from a liquidity perspective, while its synthetic version is not. Similarly, the synthetic corporate bond does not earn a liquidity premium because the CDS is usually not affected by liquidity concerns.[13]

In addition to CDS on individual issuers, there are also CDS on a group of reference entities. Index CDS offer protection against the default of any individual issuer in the underlying reference portfolio. In the empirical analysis, we use broad indices and index CDS to estimate the liquidity premium. While this reduces the power of our tests, its simplicity serves well for a first pass. And, as the robustness checks in section 4 will show, this simplification does not materially alter the results. Furthermore, index CDS like the iTraxx, are not OTC traded and, hence, the problem of illiquidity

[12] Standard CDS contracts along ISDA guidelines are collateralized and, thus, counterparty risk is minimized.

[13] In the recent past, however, even the CDS market has suffered form evaporating liquidity. Since mid-2007 CDS desks periodically appear to have been quoting excessively high prices on credit protection to deter potential buyers because the banks had no capacity left for these trades. Thus, during certain periods CDS levels contain a liquidity component as well, implying that CDS do no longer provide a clean separation of liquidity and default risk. Despite the quoting of high spreads during the outbreak of the credit crisis, evidence of liquidity effects in CDS markets has also been reported by Bühler and Trapp (2005), Nashikkar et al. (2007), Bongaerts et al. (2008) and Tang and Yan (2008). Although the latter work finds adverse selection to have an important effect on CDS liquidity, there is no evidence for the presence of informed traders impacting liquidity in the work of Acharya and Johnson (2007).

in the CDS market is even smaller than for single name CDS where studies have documented liquidity premia similar to the ones of government securities (see e.g. Tang and Yan (2008)).

To motivate the empirical model for analyzing the impact of liquidity on bond returns, we consider the well known relationship between the bond price B and its yield y. Denoting cash flows of the bond by C_t, the bond price is given by $B(y) = \sum_{t=1}^{T} \frac{C_t}{(1+y)^t}$, and the effect of a yield change can be expressed as

$$\begin{aligned} \frac{\partial B}{\partial y} &= -\frac{1}{1+y} \sum_{t=1}^{T} \left(t \frac{C_t}{(1+y)^t} \right) \\ &= -\frac{D}{1+y} B = -D^* B \end{aligned} \tag{1}$$

where D^* is the modified duration of the bond. Rearranging (1), we obtain that the bond return is approximately equal to the change in yield scaled by the duration

$$\begin{aligned} \frac{dB}{B} &= -D^* dy \\ \Rightarrow \frac{\Delta B}{B} &\approx -D^* \Delta y. \end{aligned} \tag{2}$$

Given the relationship in (2), we now decompose the yield into the compensation for time value of money, credit risk, and liquidity risk. Further, we postulate that the three factors are the same for all bonds in the sample, i.e. there exists a systematic liquidity factor in the bond universe that is captured by our liquidity proxy.

Controlling for equity performance, as motivated by Chen et al. (2007), the empirical model considered is

$$\begin{aligned} R_{i,t} &= \alpha_i + \beta_i^{(1)} \Delta \text{Rates}_t + \beta_i^{(2)} \Delta \text{Default}_t + \beta_i^{(3)} \Delta \text{Liqui}_t \\ &\quad + \beta_i^{(4)} R_t^{\text{MSCIw}} + \epsilon_{i,t} \end{aligned} \tag{3}$$

where $R_{i,t}$ is bond i^{th}'s return in period t, ΔRates_t is the change in the ten year government mid-yield corresponding to the currency of denomination of bond i, R_t^{MSCIw} is the return on the MSCI World, and $\Delta\text{Default}_t$ and ΔLiqui_t are the changes in the default and liquidity factors, respectively. In general, we will employ the CDS spread for some bond portfolio as the default risk proxy and the difference between bonds spread and CDS spread for the same portfolio as the liquidity factor proxy.

As in Jarrow (1978) and more recently in Chen et al. (2007), the regression coefficient $\beta_i^{(j)}$ represents a scaled duration. For the purpose of this study, we are primarily interested in the liquidity loading $\beta_i^{(3)}$; i.e. does our proxy for inherent liquidity risk help pricing assets? If so, and since Liqui, as backed out from certain CDS and corporate bond indices, constitutes a price in basis points, we can interpret a significant loading as evidence for the economic significance of the factor (see e.g. Elton et al. (2001) who draw a similar conclusion). Equivalently, a major advantage of our liquidity proxy lies in its immediate interpretation as a priced factor. The proxy is derived from spreads which are just a monotone transformation of bond prices. Conveniently, this allows us to dispense with a Fama and McBeth-type second-stage cross-sectional regression, which in any case would have low power due to the short time-series.

3 Data & Estimation Results

3.1 Base Case Liquidity Proxy

As the base proxy for the liquidity premium, we use the difference between the average spread of the JPMorgan EUR Investment Grade Corporate - Financials Index 5-7years (the "Index") and the CDS spread of the iTraxx Europe Senior Financials for the rolling series (the "CDS"). The advantage of these series is the large overlap between the cash index and the CDS index. We show below that neither this choice nor the non-perfect overlap materially affects our results. Figure 1 shows the two series. The corporate spread (blue, solid line) is calculated as the difference between par yields of corporate and government bonds with matching maturity. The spread for the index is the average of individual spreads weighted by the market capitalization of the bonds. The CDS spread (grey, dashed line) is from the running series, which is rolled over with the introduction of a new series. All data are month-end observations.

Figure 1 about here

Supplementing the theoretical arguments in the last section, Figure 1 provides empirical motivation for our approach. It comprises an entire economic cycle of credit spreads beginning with the high levels during the banking crisis in 2002 with its slow decline to rock-bottom levels during the recovery and boom during the mid 2000s, and finally the dramatic rise in the wake of the subprime crisis and liquidity crunch. From the graph two striking features emerge. Firstly, the two series move roughly in lock-step, reflected in a level correlation of 86%. Secondly, the corporate spread with an average of 50 basis points (bps) is consistently above the CDS level with an average of 26 bps. Thus, Figure 1 strongly supports the idea of modelling the corporate spread as the sum of two premiums and using CDS to back out the components.

Figure 2 shows the difference between the spread for JPMorgan EUR Investment Grade Corporate Financials Index and the CDS spread of the iTraxx Senior Financials Index (the blue, solid line). This difference between the spreads constitutes our candidate proxy for the the bond market liquidity premium and is denoted by $\text{Liqui}_{\text{Fin}}$.

Figure 2 about here

It is positive at all times and averaging 24 bps. In general, the spread difference starts at levels of 30 to 40 bps, then slowly but steadily drops to almost zero by 2005 and starts to rise again reaching a plateau for most of 2006 and the first half of 2007, and then increases to a range of 50 to 70 bps. It is interesting to point to the increase in the spread difference in 2005 while CDS levels continued to decline. This suggests that the price of liquidity increased long before default premiums rose again. Note that mid 2005 also approximately corresponds to the downgrades of GM and Ford shaking up credit markets.

Looking at some of the statistical properties of the series, there appears to be a somewhat larger variability at the beginning of the sample period, which might be due to limited liquidity during the infancy of CDS markets. There is markedly higher variability in the spread difference for the last 12 months of the sample period. While the spread difference exhibits some time-series variation, reflected in a monthly time-series volatility of 17 bps, the series is also quite stable. Despite high persistence, as documented by a first order auto-correlation of about 71%, the series is stationary as economic intuition suggests.[14] For comparison, the default premium denoted by Def_{Fin} and measured by the CDS spread has a monthly volatility of 21 bps and an autocorrelation of 85%.[15] Thus, the spread difference satisfies two important requirements for a return premium, namely being positive and relatively stable (in the sense of slow mean reversion) through time. Moreover, time-series variation and serial correlation are very much in line with that of the default premium. Cosequently, the preliminary analysis of time-series properties of the series itself is generally supportive of the idea that the difference captures a return premium. The time series variations of all factors (i.e. $\Delta\text{Rate}_{i,t}$, and $\Delta\text{Liqui}_{\text{Fin},t}$ and $\Delta\text{Def}_{\text{Fin},t}$) are shown in figures A1 and A2 of the appendix, respectively.

Just as some of the previously cited literature has highlighted, Figure 2 also points at a weakness of the approach - the assumption of CDS not being affected by liquidity. The development of the spread difference since mid-2007 is very volatile compared to the earlier period, and the spread difference narrows dramatically for a short time in

[14] Stationarity is confirmed using standard unit root tests, such as the ADF or KPSS test. The time series model that seems to best capture the behavior of the liquidity measure is the parsimonious ARMA(1,1) specification with AR and MA coefficients of 0.97 and -0.61, respectively.

[15] Also here, the parsimonious ARMA(1,1) specification best captures the behavior with AR and MA coefficients of 0.71 and 0.64, respectively.

spring 2008. This is due to an extreme spike in CDS spreads, which is not mirrored in the cash bond market. Thus, the sharp drop in the spread difference is driven exclusively by the increase in CDS levels. This suggests that CDS levels were not too indicative of default premiums but rather reflected the limited capacity of CDS desks at the time. To take into account potential biases arising in the sample for that unusual period, we perform our analyses both including and excluding the period post July 2007.

3.2 Estimation Methodology

We use the following JPMorgan total return indices to estimate equation (3):

- Corporate Bond Index (All Industries) USD, High Yield US, Corporate Bond Index (All Industries) EUR, Pfandbriefe EUR, Subordinated Financial EUR, Corporate Bond Index (All Industries) GBP, Senior Financials GBP, Corporate Bond Index (All Industries) JPY, Emerging Markets Global Diversified, Corporates Emerging Markets, MBS Index, ABS Index USD, CMBS Index, Munis, Hedge Funds, Loans[16]

The sample consists of monthly observations from June 2002 to June 2008; the return series are shown in figure A3 in the appendix. Since we only use the change in government yield that corresponds to the bond index's currency of denomination, equation (3) restricts the other government yields' coefficients to zero. To increase estimation efficiency and obtain standard errors that take into account cross-sectional correlation of the residuals, we estimate a Seemingly Unrelated Regression system using the first step covariance matrix as estimate for the correlation structure.

[16] Based on CLO data.

3.3 Results

Table 2 shows the estimation results when using the base proxy $\text{Liqui}_{\text{Fin}}$. As expected, the liquidity factor is mostly significantly negative. A Wald test for the joint equality of the liquidity and default coefficients can be rejected. Thus, using the liquidity component contains incremental information when compared to just regressing returns on the corporate spread of the base index.

Table 2 about here

Focusing on the liquidity coefficient, its sign is intuitively meaningful. A negative coefficient implies that prices drop when the liquidity premium increases (i.e. liquidity becomes more expensive). Also the relative magnitude of the coefficients can mostly be explained by attributes of the underlying asset. For example, the High Yield index is much more sensitive to changes in liquidity than an investment grade corporate index. The coefficent of -17.82 implies that a widening of the liquidity spread by 10bps (i.e. $\Delta\text{Liqui}_{\text{Fin}} = 10bps$) induces negative return of 1.78%. As aggregate liquidity changes of 10bps or more have very well been observed lately (compare figure 2), the estimated discount is clearly of economic significance. Strikingly, the coefficients on liquidity and default risk are typically very similar. Most of the other coefficients have easily interpretable signs and magnitudes, too. Looking, for instance, at Collaterlized EUR which are essentially Pfandbriefe, we have a rate coefficient, representing modified duration, of about -4.5 which is clearly different from zero, as must be the case for a fixed rate bond. The negative, albeit insignificant, default coefficient reflects the comparably secure nature of Pfandbriefe. It is also interesting to observe that GNMA mortgage securitues are not significantly affected by our liquidity measure, consistent with the fact that agency debt is accepted as a perfect substitute for Treasuries as repo collateral by the Fed.

For ABS, the non-existing negative return impact of the liquidity factor is counter intuitive and suggests that market participants did not see the inherent liquidity risk prior to July 2007. Repeating the estimation for the sample extending till June 2008, reveals that the ABS coefficient is no longer significantly positive, but decreasing liquidity is associated with lower returns, as one would expect (the estimation results are reported in table A1 in the appendix).[17]

To better understand the properties of the liquidity factor, the variance of returns can be decomposed according to

$$Var(R_i) = \sum_{j=1}^{4} \left(\beta_i^{(j)}\sigma_j\right)^2 + 2\sum_{j=1}^{3}\sum_{k=j+1}^{4} \beta_i^{(j)}\beta_i^{(k)}\sigma_j\sigma_k\rho_{jk} + \sigma_i^2 \quad (4)$$

where σ_j^2 is the variance of factor $j = 1, ..., 4$, ρ_{jk} is the correlation between factors j and k, and $\sigma_i^2 = E\left[\epsilon_i^2\right]$. The equation shows that, were regressors uncorrelated, identifying the relative importance of the liquidity factor would be a straightforward task based on the sum of squares.

Table 3 about here

From equation (4) it is obvious that relative importance based on sum of squares is at best indicative when uncorrelatedness of regressors cannot be assumed. Nonetheless, the increase in R^2, when the liquidity component is added, reveals the usefulness of the variable to some degree. Following convention, the effect of adding the liquidity factor to the model containing all other regressors is given in table 3. Looking, for example, at USD corporate investment grade bonds, inclusion of the liquidity factor enhances the explanatory power of the model by 8.9%. The importance of

[17] When regressing the returns on each factor individually, the rate component is the most important one with a significantlu negative relationship that can, in some cases, explain more than 90% of the variation in returns. The liquidity factor, on average, explains about 8% of return variation with most of the significant coefficents being negative. A similar picture emerges for MSCI returns and the default component. Results are available upon request.

the liquidity variable for high yield bonds (incremental R^2 of 32%) and, contrary, the small effect for GNMA mortgage securities[18] hint at the, often cited, "flight to quality" phenomenon. The average effect of 9% indicates a substantially improved model performance.

Altogether, these results suggest that we have discovered a priced liquidity component that significantly relates to various bond returns and, hence, is of economic importance. It allows, for example, long term investors who are not driven by short term liquidity concerns to identify assets for which they can reap a liquidity premium given the amount of credit risk they are willing to take.

4 Robustness & Latent Liquidity

4.1 Alternative Proxies

So far, we have used the liquidity component of senior financials as proxy to capture the salient factors of bond market liquidity. As robustness check we repeat the analysis with a different proxy for the liquidity premium $\text{Liqui}_{\text{Corp}}$ obtained from the difference of the government spread of the JPMorgan EUR Investment Grade Corporates Index and the CDS spread of the iTraxx Europe Main. The results of the estimation are very similar to the ones of the previous section; they are reported in table A2 of the appendix. This hints at both liquidity proxies capturing one and the same underlying liquidity factor of the bond market.

Following Duffie et al. (2003) and market convention, another measure sometimes considered as a proxy for the liquidity premium is the swap spread, which measures the difference in yields between rates for interest rate swaps and corresponding government bonds (Figure 3). An interest rate swap is a contract that stipulates the counterparties to exchange a floating rate, typically 3 or 6 month LIBOR, versus a

[18] Recall that GNMAMortgage securities are equivalent to US Treasuries from a collateral perspective.

specific fixed rate, for the duration of the contract, say 10 years. A funded position demands a combination of a 10 year LIBOR floating rate note plus the swap.

The swap itself carries hardly any credit risk because counterparty risk is virtually eliminated by requiring collateral to the extent of the mark-to-market of the swap. Thus, the only credit risk of the position is that of the LIBOR floating rate note. Issuers persistently paying approximately LIBOR flat for term funding are typically premium quality sub-sovereign.

In summary, the 10 year swap rate reflects 10 years credit risk of an issuer substantially better than AA and a liquidity premium for 10 years on the underlying note. Given the quality of the issuers, compensation for credit risk should in general be a relatively minor component of the swap spread. However, during the recent credit crisis LIBOR rates probably have been reflecting substantially larger credit risk components. Accordingly, swap spreads should be more strongly related to default risk in the recent past, and, therefore, a less reliable measure of the liquidity premium than our proxy.

As expected, Figure 3 shows that the EUR swap spread and the CDS based liquidity proxy are significantly correlated. For the full sample, the correlation coefficient (between levels) is 0.79, whereas, surprisingly, the correlation is considerably lower at 0.54 for the period up to June 2007. On the other hand, a multiple regression of swap spreads on CDS levels and the liquidity proxy shows that swap spreads are associated with changes in default risk as well. The coefficient on the CDS levels is statistically significant, and the R^2 of the regression is 70%. However, decomposing the variance shows that 62% of the swap spread variation is due to variation in the liquidity proxy. Thus, the swap spread is, at least, also a reasonable proxy for the liquidity premium. As such, it is not surprising that the estimation results for equation (3) are qualitatively similar to the previous two proxies; results are shown in table A3 of the appendix.

Throughout the paper we have advocated an index based approach to back out the liquidity component. Despite its simplicity, this type of analysis may suffer from a mismatch between Index and CDS. This is due to the composition of the underlying portfolios differing slightly. While the Index contains issues denominated in EUR by global financials (basically the largest European and US banks), the reference portfolio comprises only European financials; the Index is market-weighted, while the CDS reference is equally-weighted; the Index contains issues with a range of maturities from 5 to 7 years; while the maturity of the CDS is at most 5 years and then rolling down to nearest reset of the contract in six months. While the measurement error due to this mismatch could be large, repeating the analysis with exactly matching samples corroborates the previous findings. Since we unfortunately have data for a matching sample of CDS and bond spreads only for the period January 2005 till June 2007, we do not use these series for the original analysis. The results in table A4 of the appendix largely confirm the previous coefficient estimates. Again the liquidity sensitivities are negative and relative magnitudes are intuitive (e.g. high yield bond returns respond much more to changes in liquidity than investment grade corporates).

Lastly, we reestimate the model using weekly data. As expected, the noise significantly weakens the results, albeit them still pointing into the right direction; results are available upon request.

4.2 Latent Liquidity

The robustness checks of the previous section have shown that different candidate measures produce qualitatively similar results. This suggests that they all proxy the same underlying latent liquidity factor of the bond market. We formally take up this idea of latent liquidity, following Korajczyk and Sadka (2008), and perform a principal component analysis (PCA) using the introduced factors $\text{Liqui}_{\text{Fin}}$, $\text{Liqui}_{\text{Corp}}$, and $\text{Liqui}_{\text{Swap}}$ which are available for the entire sample. Since the unit of measurement is equivalent for all three series, we can decompose the variation based on the covariance matrix to give the resulting principal components (PCs) a meaningful interpretation in terms of basis points. It turns out that the first principle component, $\text{Liqui}_{\text{PCA}}$, explains almost 80% of the variation. Figure 3 compares the three previously introduced proxies as well as the just described first PC. Besides the principal component having an intuitive interpretation in terms of latent liquidity, the approach also serves to alleviate the potential bias arising from the classical errors in variables problem.

Figure 3 about here

Table 4 about here

Using the principal component of our liquidity measures to capture latent liquidity and the default PC obtained from Def_{Fin} and Def_{Corp}, we again estimate the model (equation (3)). Table 4 shows the estimation output.

Accounting for the fact that liquidity is a latent factor, the PCA allows to capture the salient features of the variation in liquidity. The resulting liquidity coefficients mirror the previously discussed estimation results, while R^2s are slightly higher, hinting at a superior liquidity proxy. Negativity of the coefficients again implies that bond returns decrease as illiquidity increases. Also again, the impact of the liquidity measure varies in accordance with expectation. We interpret these findings as evidence for the existence of a latent liquidity factor in the bond market. That is, bond returns are affected, albeit to differing degrees, by the same, easily obtained, liquidity premium.

4.3 Volatility and Liquidity

Low liquidity appears to coincide with markets becoming more volatile. Following the literature (see e.g. Bao et al. (2008)), we, thus, investigate the relation between our liquidity measure and equity volatility, partly to make sure our regression estimates are not due to an omitted variable problem. Because standard implied volatility indices such as VIX (S&P 500), VDAX (DAX), and V2X (DJ Euro Stoxx 50) are highly correlated at 97% for the sample period 2002-07, we only focus on the VIX as control for the fear gauge of the market.

Regressing changes of the liquidity factor on changes in VIX, we find a significantly positive relationship, indicating the increasing bond illiquidity tends to be associated with a lower risk appetite of the market. The coefficient estimate for the sample extending till 2007 is 0.0137 with corresponding p-value < 0.001 and adjusted R^2 of 12%; for the entire sample the estimated coeffient is 0.016 with p-value < 0.005 and adjusted R^2 of 9%.

Despite the significant relationship between the liquidity proxy and the VIX, our conclusions concerning the statistical and economic importance of the liquidity measure are not altered. Controlling for market volatility, we estimate the following model

$$\begin{aligned} R_{i,t} &= \alpha_i + \beta_i^{(1)} \Delta \mathrm{Rates}_t + \beta_i^{(2)} \Delta \mathrm{Default}_t + \beta_i^{(3)} \Delta \mathrm{Liqui}_t \\ &\quad + \beta_i^{(4)} R_t^{\mathrm{MSCIw}} + \beta_i^{(5)} \Delta \mathrm{VIX}_t + \epsilon_{i,t}. \end{aligned} \tag{5}$$

Estimation results are contained in table A5 of the appendix. Not only does the liquidity factor remain significant, but the volatility measure is actually insignificant for almost all assets considered. For those equations in which it is significant, the liquidity coefficient is smaller in absolute terms when compared to the estimates in which volatility is not included in the regression. Overall, the results do not seem to imply that the liquidity effect is subsumed by the volatility effect.

5 Maturity & Rating

To analyze the impact of maturity and rating category on the sensitivity to liquidity, we obtain data for sub-classes of the previously considered indices with 1-3 years, 3-5 years, 5-7 years, 7-10 years, 10+ years maturities and available rating categories. We then estimate a restricted version of the empirical model, where the $\Delta\text{Liqui}_{\text{PCA}}$ coefficients are set to be the same for each maturity (rating class).

5.1 Maturity

Intutively, one expects a natural link between the liquidity discount of an investment and its maturity. Everything else equal, liquidity should affect to a lesser extent prices of bonds with shorter remaining time to maturity. For example, in Longstaff's (Longstaff, 2005) two-tree economy agents with high time preference discount the illiquid asset more heavily than the liquid asset as maturity increases. In addition, the haircut rules in repo markets imply a strong link between maturity and liquidity because bonds with longer maturities suffer larger haircuts.

For an asset with T years to maturity equations of the following type comprise the SUR system

$$\begin{aligned} R_{i,t} &= \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_{\mathbf{T}}^{(\mathbf{3})}\Delta\text{Liqui}_t \\ &\quad + \beta_i^{(4)} R_t^{\text{MSCIw}} + \epsilon_{i,t}. \end{aligned} \tag{6}$$

Longer maturities appear indeed to be associated with a larger sensitivity to liquidity as Table 5 indicates. Apart from two exceptions, the liquidity loading monotonically increases (in absolute terms) with maturity. A Wald test further confirms the statistical difference of the coefficents of different maturities.[19] Taking a closer look at the maturity impact for EUR denominated assets, we can compare the price effects with

[19] For completeness, the unrestricted coefficient estimates of the remaining parameters in the EUR case are given in table A6 of the appendix.

the change in ECB haircuts for different maturities. As the here considered assets are all issued by corporates or financial institutions, the EUR numbers of table 5 should be matched up to the haircuts applied to Category III assets in table 1. When doing this, we find that market prices for different maturities react to changes in liquidity much in line with the ECB implied ranking in terms of collateral acceptance. For example, the difference in haircuts between 3-5 and 5-7 year maturity, fixed coupon, Category III assets is 1.5%. Table 5 shows that the incremental effect of 1.6 of moving from the 3-5 year to the 5-7 year maturity range is almost identical for market implied data.

Table 5 about here

A comparison of EUR and USD maturities further shows that the USD assets are much less sensitive to changes in liquidity than the EUR issues. This reflects the much bigger size of USD denominated asset markets and should not be surprising. For GBP issues the coefficient estimates do not neatly fit into the picture, though. As the market for GBP bonds is much smaller than for EUR or USD counterparts, we would expect coefficients to be larger in absolute value than the USD or EUR ones. One possible explanation for the absence of this is the different decomposition of the assets used for estimation. As such it is possible that the GBP assets are inherently more liquid which then does not imply that the GBP market is in general more liquid than the other two. A second explanation refers to the classical error-in-variables (CEV) problem. Considering the CEV setup

$$\text{Liqui Proxy} = \text{Global Factor} + \text{measurement error}, \tag{7}$$

a correlation between the proxy and the measurement error (i.e. local liquidity factor) leads to a downward bias of the coefficient estimate. The liquidity proxy that has been employed is based on indices and iTraxx series (as well as swaps) comprising

EUR and USD issuers. For these two currencies we can expect the measurement error impact to be negligible. This need not be true for GBP bonds, though, and the small coefficient estimates can be reconciled with the correlation of proxy and error introducing an attenuation bias in the estimates.

5.2 Rating

Similarly, there is a strong intuition for a link between liquidity and credit quality. Ericsson and Renault (2006) show that credit quality and liquidity premium can be linked through a renegotiation game in financial distress, when illiquidity is adversly affecting the bargaining power of the bond holder. At a more practical level, regulatory constraints and investor governance tend to narrow the investor base as ratings worsen. Thus, potential demand for lower quality is thinner implying lower liquidity. Furtermore, lower credit qualities are less likely to be accepted as collateral, or at least at larger haircuts, in interbank repo.

In general, these predictions are borne out in the data; lower ratings are associated with larger sensitivities to liquidity. Restricting the liquidity coefficients to be the same for each rating class (similar in spirit to equation (6)), table 6 shows the estimates for the sample in- and excluding July 2007 till June 2008.

Table 6 about here

The findings support the notion of flight to quality; i.e. high quality assets are less affected by liquidity. Almost without exception, the impact of liquidity decreases with credit quality for both sample periods with differences being statistically significant. Investors' demand, and subsequently the market size, for high quality issues rises during turbulent times. A comparison of coefficient estimates for the different samples further confirms the flight to quality idea. The AAA coefficient for USD issues becomes indistinguishable from zero and lower credit qualities are punished by an even bigger liquidity discount compared to the smaller sample.

6 Concluding Remarks

The paper has investigated the relation of bond returns and changes in the non-default component of corporate spreads which is interpreted as liquidity premium. Time series properties of the spread difference support this interpretation as well as the results do. With the considered liquidity measures proxying the same underlying latent bond market liquidity, a principal component analysis allows us to obtain a liquidity factor that represents a priced component and significantly relates to the cross-section of bond returns considered. Liquidity coefficients indicate that returns are negatively affected by declining liquidity and magnitudes allow the identification of assets particularly influenced by liquidity. Looking at the effect of credit quality, the estimates reflect the flight to quality. For different maturities, the maturity-dependent size of the ECB haircuts is well reflected in market data. These results imply that there exists a statistically and economically significant liquidity factor in bond markets that can be backed out using CDS.

Especially for long-term investors, these findings can be very important. Given the amount of credit risk they are willing to bear, they should focus on bonds that are more sensitive to liquidity, as this will allow them to reap a liquidity premium. For them this constitutes an extra return and not a compensation for risk, as they are unlikely to be involved in fire-sales and can divest when most lucrative from a liquidity perspective. For valuation purposes, the approach allows to obtain a liquidity discount for a particular asset. This promises to be an easily implementable way to meet account standard setters' demand of adjusting market prices for liquidity. Also for risk managers, the presented approach offers a feasible opportunity to identify the portfolio's sensitivity to liquidity.

Lastly, the robustness checks have shown that the implications of slightly mismatched indices are not material as results are similar when using the exactly matching data. In terms of illiquidity in the CDS market, the period following the wake of the subprime crisis is likely to remain special. The used index CDS are standard contracts that are exchange traded such that the proposed model can be easily implemented in the future.

References

(2008). *Outcome of the biennial review of the risk control measures in Eurosystem credit operations*, Frankfurt am Main, Germany. European Central Bank.

Acharya, V. and Johnson, T. (2007). Insider trading in credit derivatives. *Journal of Financial Economics*, 84(1):110–141.

Amihud, Y. (2002). Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets*, 5(1):31–56.

Amihud, Y. and Mendelson, H. (1986). Asset pricing and the bid-ask spread. *Journal of Financial Economics*, 17(2):223–249.

Amihud, Y. and Mendelson, H. (1991). Liquidity, maturity, and the yields on u.s. treasury securities. *Journal of Finance*, 46(4):1411–25.

Amihud, Y., Mendelson, H., and Pedersen, L. H. (2005). *Liquidity and Asset Prices*. now, Boston.

Bao, J., Pan, J., and Wang, J. (2008). Liquidity of Corporate Bonds. *SSRN eLibrary*.

Bongaerts, D., de Jong, F., and Driessen, J. (2008). Derivative pricing with liquidity risk: Theory and evidence from the credit default swap market. Working Paper University of Amsterdam.

Brunnermeier, M. K. and Pedersen, L. H. (2007). Market liquidity and funding liquidity. Nber working papers, National Bureau of Economic Research, Inc.

Bühler, W. and Trapp, M. (2005). A credit risk model with liquidity in CDS and bond markets. Working Paper, University of Mannheim.

Chen, L., Lesmond, D. A., and Wei, J. (2007). Corporate yield spreads and bond liquidity. *Journal of Finance*, 62(1):119–149.

Collin-Dufresne, P., Goldstein, R., and Helwege, J. (2002). Are jumps in corporate bond yields priced? Modeling contagion via the updating of beliefs. *Unpublished working paper, Carnegie Mellon University*.

Collin-Dufresne, P., Goldstein, R., and Martin, J. (2001). The Determinants of Credit Spread Changes. *Journal of Finance*, 56(6):2177–2207.

De Jong, F. and Driessen, J. (2005). Liquidity Risk Premia in Corporate Bond Markets. *SSRN eLibrary*.

Downing, C., Underwood, S., and Xing, Y. (2005). Is Liquidity Risk Priced in the Corporate Bond Market. Technical report, working paper Rice University.

Duffie, D. (1999). Credit Swap Valuation. *Financial Analysts Journal*, 55(1):73–87.

Duffie, D., Pedersen, L., and Singleton, K. (2003). Modeling Sovereign Yield Spreads: A Case Study of Russian Debt. *Journal of Finance*, 58(1):119–159.

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

Edwards, A., Harris, L., and Piwowar, M. (2007). Corporate Bond Market Transparency and Transaction Costs. *Journal of Finance*, 62(3):1421–51.

Elton, E. J., Gruber, M. J., Agrawal, D., and Mann, C. (2001). Explaining the rate spread on corporate bonds. *Journal of Finance*, 56(1):247 – 277.

Ericsson, J. and Renault, O. (2006). Liquidity and credit risk. *Journal of Finance*, 61(5):2219–2250.

Fama, E. and French, K. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33(1):3–56.

Goldstein, M., Hotchkiss, E., and Sirri, E. (2007). Transparency and Liquidity: A Controlled Experiment on Corporate Bonds. *Review of Financial Studies*, 20(2):235.

Huang, J.-Z. J. and Huang, M. (2003). How Much of Corporate-Treasury Yield Spread Is Due to Credit Risk?: A New Calibration Approach. *SSRN eLibrary*.

Jankowitsch, R., Nashikkar, A. J., and Subrahmanyam, M. G. (2008). Price Dispersion in OTC Markets: A New Measure of Liquidity. *SSRN eLibrary*.

Jarrow, R. (1978). The relationship between yield, risk, and return of corporate bonds. *Journal of Finance*, 33(4):1235–1240.

Korajczyk, R. A. and Sadka, R. (2008). Pricing the commonality across alternative measures of liquidity. *Journal of Financial Economics*, 87(1):45–72.

Lesmond, D. A., Ogden, J. P., and Trzcinka, C. A. (1999). A new estimate of transaction costs. *Review of Financial Studies*, 12(5):1113–41.

Longstaff, F. (2004). The Flight-to-Liquidity Premium in US Treasury Bond Prices*. *The Journal of Business*, 77(3):511–526.

Longstaff, F. (2005). Asset pricing in markets with illiquid assets. Working paper, niversity of California Los Angeles, working paper.

Longstaff, F. A., Mithal, S., and Neis, E. (2005). Corporate Yield Spreads: Default Risk or Liquidity? new Evidence from the Credit-Default Swap Market. *Journal of Finance*, 60(5):2213–2253.

Mahanti, S., Nashikkar, A., and Subrahmanyam, M. (2007). Latent Liquidity and Corporate Bond Yield Spreads. Technical report.

Mahanti, S., Nashikkar, A., Subrahmanyam, M., Chacko, G., and Mallik, G. (2008). Latent liquidity: A new measure of liquidity, with an application to corporate bonds. *Journal of Financial Economics*, 88(2):272–298.

Nashikkar, A., Subrahmanyam, M., and Mahanti, S. (2007). Latent Liquidity and Corporate Bond Yield Spreads. Technical report.

Pastor, L. and Stambaugh, R. F. (2003). Liquidity risk and expected stock returns. *Journal of Political Economy*, 111(3):642–685.

Tang, D. Y. and Yan, H. (2008). Liquidity and Credit Default Swap Spreads. *SSRN eLibrary*.

Table 1: *ECB haircuts for marketable assets in %*

	Cat. I (sov. bonds)		Cat. II (sub-sov. bonds)		Cat. III (bank & corp.)		Cat. IV (bank loans)		Cat. V ABS
Res. Mat.	Fixed C	Zero	Fixed C	Zero	Fixed C	Zero	Fixed C	Zero	all Coupons
0-1	0.5	0.5	1	1	1.5	1.5	6.5	6.5	12
1-3	1.5	1.5	2.5	2.5	3	3	8	8	12
3-5	2.5	3	3.5	4	4.5	5	9.5	10	12
5-7	3	3.5	4.5	5	5.5	6	10.5	11	12
7-10	4	4.5	5.5	6.5	6.5	8	11.5	13	12
>10	5.5	8.5	7.5	12	9	15	14	20	12

Source: ECB (2008)

Table 2: *Estimation Results using $Liqui_{Fin}$*

Sample 2002 M06 - 2007 M07	1	R_{MSCIw}	Coefficients of ΔRate	$\Delta\text{Liqui}_{\text{Fin}}$	$\Delta\text{Def}_{\text{Fin}}$	R^2
CorpIG USD	0.0040 *	0.0636 *	-5.4712 *	**-8.4055 ***	-7.5330 *	94.67%
HY US	0.0069 *	0.1592 *	-1.7145 *	**-17.8235 ***	-16.0749 *	65.71%
CorpIG EUR	0.0039 *	0.0037	-4.1176 *	**-4.8266 ***	-4.0157 *	90.48%
Collateralized EUR	0.0031 *	-0.0151	-4.4629 *	**-1.2829 ***	-0.5213	94.83%
FinSub EUR	0.0044 *	-0.0115	-5.5412 *	**-7.1393 ***	-6.6085 *	91.71%
CorpIG GBP	0.0044 *	0.0454 *	-6.5186 *	**-4.6568 ***	-5.8772 *	91.92%
FinSen GBP	0.0043 *	0.0103	-5.5198 *	**-4.7719 ***	-6.1825 *	95.17%
CorpIG JPY	0.0007 *	0.0013	-1.9189 *	**-2.1348 ***	-1.7226 *	63.14%
EMBIGlobDiv USD	0.0070 *	0.3717 *	-6.1014 *	**-10.8285 ***	-8.5150 *	70.14%
CorpEM USD	0.0064 *	0.1002 *	-6.5743 *	**-7.9745 ***	-9.2069 *	88.56%
GNMAMortgages USD	0.0033 *	0.0246	-2.2911 *	**-0.3356**	1.5272	73.84%
ABS USD	0.0033 *	-0.0041	-1.6394 *	**1.0604 ***	1.1193 *	89.21%
CMBS USD	0.0039 *	0.0246	-4.9613 *	**-1.0670**	-1.4887	93.95%
Munis USD	0.0043 *	0.0094	-4.8031 *	**-3.7824 ***	-5.8674 *	88.29%
HedgeFunds USD	0.0063 *	0.3228 *	-0.60219	**-1.9831**	-7.1210 *	68.13%
Loans USD	0.0045 *	0.0107	0.06897	**-9.3315 ***	-14.0000 *	66.25%

NOTE: Table displays estimates of regressing bond index returns on factors in a seemingly unrelated regression framework according to $R_{i,t} = \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_i^{(3)}\Delta\text{Liqui}_t + \beta_i^{(4)} R_t^{\text{MSCIw}} + \epsilon_{i,t}$; * indicates significance at the 95% level; inference is based on robust standard errors

Table 3: *Explanatory power associated with $\Delta Liqui_{Fin}$ based on R^2*

	CorpIG USD	CorpIG GBP	EMBIGlobDiv USD	HY US	FinSub EUR	CorpEM USD
ΔR^2	8.89%	4.56%	6.87%	32.31%	12.42%	5.53%

		CorpIG EUR	GNMAMortgages USD	HedgeFunds USD	FinSen GBP	CMBS USD
ΔR^2		10.43%	0.06%	0.61%	6.72%	0.19%

		CorpIG JPY	Collateralized EUR	Munis USD	ABS USD	Loans USD
ΔR^2		11.15%	0.67%	2.01%	1.16%	39.59%

Mean	8.95%

NOTE: Table displays the increase in R^2 when adding the liquidity factor as regressor in $R_{i,t} = \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_i^{(4)}R_t^{\text{MSCIw}} + \epsilon_{i,t}$

Table 4: *Estimation Results using $Liqui_{PCA}$*

Sample 2002 M06 - 2007 M07	1	R_{MSCIw}	Coefficients of ΔRate	$\Delta\text{Liqui}_{\text{PCA}}$	$\Delta\text{Def}_{\text{PCA}}$	R^2
CorpIG USD	0.0039 *	0.0600 *	-5.4626 *	**-4.9412 ***	-5.5128 *	94.79%
HY US	0.0067 *	0.1511 *	-1.6287 *	**-10.3327 ***	-11.4927 *	65.13%
CorpIG EUR	0.0038 *	-0.0051	-4.1462 *	**-3.4293 ***	-3.2425 *	92.80%
Collateralized EUR	0.0031 *	-0.0185 *	-4.4698 *	**-1.0962 ***	-0.7619 *	95.10%
FinSub EUR	0.0043 *	-0.0190	-5.5734 *	**-4.5373 ***	-4.7153 *	92.60%
CorpIG GBP	0.0045 *	0.0282 *	-6.5814 *	**-3.5733 ***	-3.3816 *	93.11%
FinSen GBP	0.0043 *	0.0038	-5.5431 *	**-2.7852 ***	-3.2358 *	94.34%
CorpIG JPY	0.0007 *	0.0014	-1.9229 *	**-1.2323 ***	-1.1182 *	60.73%
EMBIGlobDiv USD	0.0070 *	0.3396 *	-6.1486 *	**-8.6978 ***	-6.7831 *	72.73%
CorpEM USD	0.0064 *	0.0911 *	-6.5353 *	**-4.5989 ***	-5.1796 *	88.04%
GNMAMortgages USD	0.0033 *	0.0256	-2.2643 *	**-0.4314**	0.3454	73.57%
ABS USD	0.0034 *	-0.0081	-1.6545 *	**0.2374**	0.7604 *	89.75%
CMBS USD	0.0040 *	0.0132	-5.0051 *	**-1.4035 ***	-0.8469	94.32%
Munis USD	0.0043 *	0.0104	-4.7758 *	**-1.4868**	-2.3553 *	87.17%
HedgeFunds USD	0.0064 *	0.3217 *	-0.5959	**-0.0769**	-2.9332 *	69.31%
Loans USD	0.0044 *	0.0160	0.0653	**-3.7289 ***	-6.2092 *	51.88%

NOTE: Table displays estimates of regressing bond index returns on factors in a seemingly unrelated regression framework according to $R_{i,t} = \alpha_i+\beta_i^{(1)}\Delta\text{Rates}_t+\beta_i^{(2)}\Delta\text{Default}_t+\beta_i^{(3)}\Delta\text{Liqui}_t+\beta_i^{(4)}R_t^{\text{MSCIw}}+\epsilon_{i,t}$; * indicates significance at the 95% level; inference is based on robust standard errors

Table 5: *Effect of varying maturity for different currencies*

Maturity	$\beta_{\mathbf{T}}^{(\mathbf{3})}$		
	EUR	GBP	USD
1-3	-2.5860 *	-0.4085 *	-0.5581^{+}
3-5	-3.4812 *	-0.6537 *	-1.0466 *
5-7	-5.1421 *	-1.6851 *	-2.1539 *
7-10	-4.1691 *	-2.7080 *	-3.3929 *
10+	-7.7848 *	-4.3314 *	-3.2713 *

NOTE: Table displays liquidity coefficient estimates when restricting the liquidity impact to be the same for each maturity group and Euro (EUR), Sterling (GBP) and US-Dollar (USD) currency of denomination: $R_{i,t} = \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_{\mathbf{T}}^{(\mathbf{3})}\Delta\text{Liqui}_t + \beta_i^{(4)}R_t^{\text{MSCIw}} + \epsilon_{i,t}$; * indicates significance at the 95% level; $^+$ indicates at the 90% level

Table 6: *Effect of rating class for different currencies*

Rating	$\Delta\text{Liqui}_{\text{PCA}}$ Coefficient					
	EUR		GBP		USD	
Sample	'02 - '07	'02 - '08	'02 - '07	'02 - '08	'02 - '07	'02 - '08
AAA	-	-	-1.3900 *	-1.5429 *	-0.5288 $^{+}$	-0.7240
AA	-2.8053 *	-3.8979 *	-1.8680 *	-2.8971 *	-0.9067 *	-1.2340 *
A	-2.6965 *	-4.3233 *	-2.1652 *	-3.2325 *	-1.1326 *	-2.3844 *
BBB	-6.8641 *	-6.5974 *	-3.3608 *	-3.1099 *	-3.6986 *	-4.1414 *

NOTE: Table displays liquidity coefficient estimates when restricting the liquidity impact to be the same for each rating class and Euro (EUR), Sterling (GBP) and US-Dollar (USD) currency of denomination for the time periods in- and excluding July 2007 till June 2008: $R_{i,t} = \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_{\text{Mat}}^{(\mathbf{3})}\Delta\text{Liqui}_t + \beta_i^{(4)}R_t^{\text{MSCIw}} + \epsilon_{i,t}$; * indicates significance at the 95% level; $^+$ indicates at the 90% level

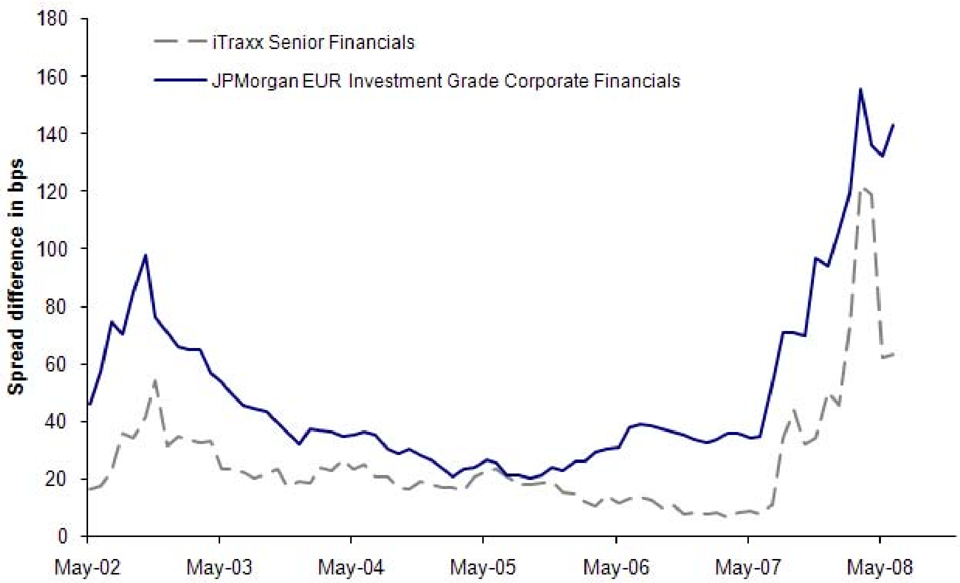

Figure 1: *CDS and Corporate Spreads of Senior Financials*

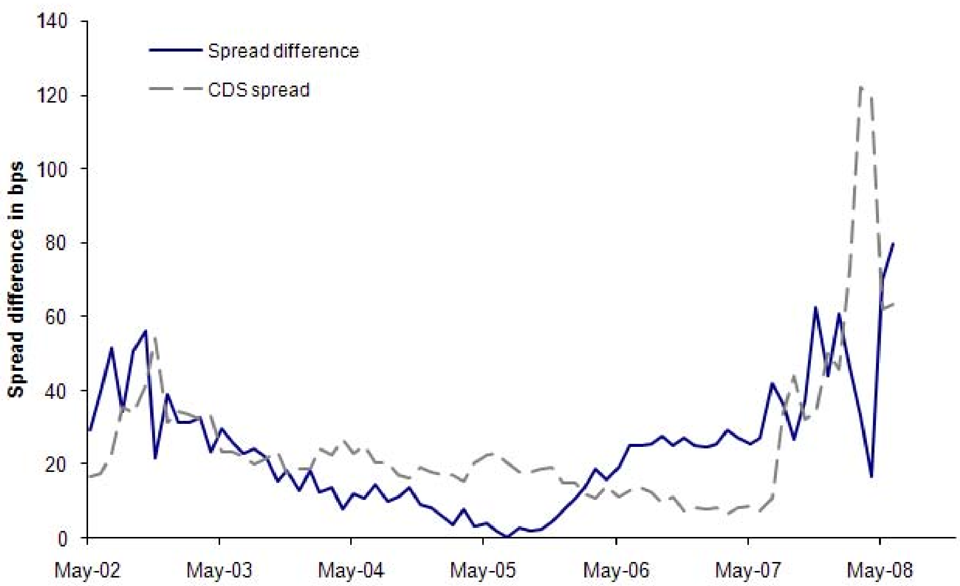

Figure 2: *Spread Difference of Senior Financials*

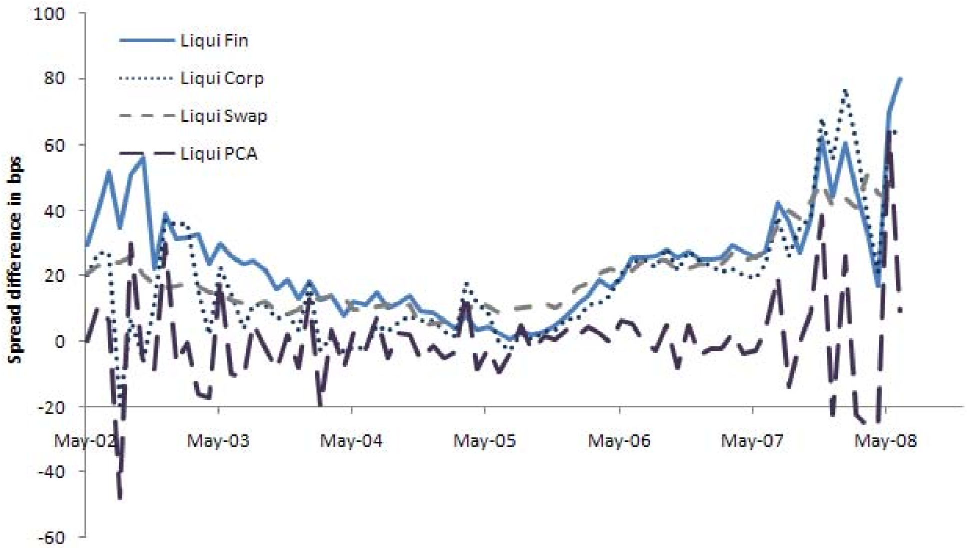

Figure 3: *Considered liquidity proxies*

Appendix

Table A1: *Entire Sample Estimation Results using* $Liqui_{Fin}$

Sample			Coefficients of			
2002 M06 - 2008 M06	1	R_{MSCIw}	ΔRate	$\Delta\text{Liqui}_{\text{Fin}}$	$\Delta\text{Def}_{\text{Fin}}$	R^2
CorpIG USD	0.0042 *	0.0688 *	-5.4973 *	**-7.0613 ***	-6.3691 *	93.95%
HY US	0.0072 *	0.1965 *	-1.8786 *	**-12.0816 ***	-9.1759 *	63.32%
CorpIG EUR	0.0039 *	0.0130	-4.2356 *	**-4.3893 ***	-4.2963 *	91.09%
Collateralized EUR	0.0030 *	-0.0092	-4.4316 *	**-1.5969 ***	-1.4661 *	93.88%
FinSub EUR	0.0045 *	-0.0040	-5.3566 *	**-9.8872 ***	-10.1923 *	88.41%
CorpIG GBP	0.0045 *	0.0434 *	-6.5460 *	**-5.2086 ***	-6.1856 *	89.47%
FinSen GBP	0.0045 *	0.0049	-5.4241 *	**-5.8269 ***	-6.4276 *	93.40%
CorpIG JPY	0.0007 *	-0.0079	-2.0244 *	**-2.5815 ***	-1.9805 *	55.71%
EMBIGlobDiv USD	0.0076 *	0.3565 *	-6.0822 *	**-6.7731 ***	-5.9880 *	65.73%
CorpEM USD	0.0064 *	0.1201 *	-6.3810 *	**-7.5260 ***	-7.8312 *	83.72%
GNMAMortgages USD	0.0035 *	0.0311 *	-2.3487 *	**0.2042**	0.4301	73.99%
ABS USD	0.0027 *	-0.0102	-1.6576 *	**-0.6954**	-1.6617 *	69.33%
CMBS USD	0.0033 *	0.0757 *	-4.7330 *	**-2.2993**	-2.7720 *	66.18%
Munis USD	0.0039 *	0.0497	-4.7168 *	**-3.0445**	-4.4144 *	58.66%
HedgeFunds USD	-0.0113	1.3966 *	-4.4399	**2.1276**	-3.4633	16.72%
Loans USD	0.0046 *	0.0444	-0.0722	**-7.2084 ***	-7.1370 *	51.60%

NOTE: Table displays estimates of regressing bond index returns on factors in a seemingly unrelated regression framework according to $R_{i,t} = \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_i^{(3)}\Delta\text{Liqui}_t + \beta_i^{(4)} R_t^{\text{MSCIw}} + \epsilon_{i,t}$; * indicates significance at the 95% level; inference is based on robust standard errors

Table A2: *Estimation Results using* $Liqui_{Corp}$

Sample 2002 M06 - 2007 M07	1	R_{MSCIw}	Coefficients of ΔRate	$\Delta\text{Liqui}_{\text{Corp}}$	$\Delta\text{Def}_{\text{Corp}}$	R^2
CorpIG USD	0.0036 *	0.0668 *	-5.4340 *	**-5.4338 ***	-6.4819 *	94.02%
HY US	0.0060 *	0.1661 *	-1.5849 *	**-11.3322 ***	-13.4837 *	62.25%
CorpIG EUR	0.0037 *	-0.0015	-4.1514 *	**-3.9850 ***	-4.0411 *	92.31%
Collateralized EUR	0.0031 *	-0.0168 *	-4.4720 *	**-1.2449 ***	-0.9967 *	95.00%
FinSub EUR	0.0040 *	-0.0134	-5.5758 *	**-5.1564 ***	-5.6903 *	91.74%
CorpIG GBP	0.0043 *	0.0275 *	-6.5461 *	**-4.4789 ***	-4.3642 *	93.54%
FinSen GBP	0.0041 *	0.0053	-5.5231 *	**-3.2744 ***	-3.8594 *	94.06%
CorpIG JPY	0.0006 *	0.0040	-1.9374 *	**-1.3207 ***	-1.3200 *	59.26%
EMBIGlobDiv USD	0.0067 *	0.3450 *	-6.0891 *	**-10.3230 ***	-8.8685 *	72.62%
CorpEM USD	0.0061 *	0.0960 *	-6.5122 *	**-5.2015 ***	-6.0909 *	87.62%
GNMAMortgages USD	0.0033 *	0.0276	-2.2342 *	**-0.3168**	0.3654	73.31%
ABS USD	0.0034 *	-0.0091	-1.6688 *	**0.1200**	0.7352 *	89.78%
CMBS USD	0.0039 *	0.0125	-5.0217 *	**-1.9057 ***	-1.3094 *	94.48%
Munis USD	0.0042 *	0.0124	-4.7676 *	**-1.5953**	-2.5523 *	86.96%
HedgeFunds USD	0.0062 *	0.3177 *	-0.6582	**-0.4505**	-3.2179 *	69.07%
Loans USD	0.0040 *	0.0221	0.0596	**-3.9624 ***	-6.7332 *	47.83%

NOTE: Table displays estimates of regressing bond index returns on factors in a seemingly unrelated regression framework according to $R_{i,t} = \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_i^{(3)}\Delta\text{Liqui}_t + \beta_i^{(4)} R_t^{\text{MSCIw}} + \epsilon_{i,t}$; * indicates significance at the 95% level; inference is based on robust standard errors

Table A3: *Estimation Results using $Liqui_{Swap}$*

Sample 2002 M06 - 2007 M07	Coefficients of 1	R_{MSCIw}	ΔRate	$\Delta\text{Liqui}_{\text{Swap}}$	$\Delta\text{Def}_{\text{Fin}}$	R^2
CorpIG USD	0.0038 *	0.1132 *	-5.4828 *	**-8.0122 ***	-0.7249	87.10%
HY US	0.0063 *	0.2712 *	-1.7586 *	**-14.5849**	-1.6358	36.93%
CorpIG EUR	0.0038 *	0.0286 *	-4.2209 *	**-6.8017 ***	-0.0849	83.55%
Collateralized EUR	0.0032 *	-0.0164 *	-4.5299 *	**-5.2344 ***	0.5440	96.00%
FinSub EUR	0.0042 *	0.0301	-5.6668 *	**-7.9878 ***	-0.8071	81.90%
CorpIG GBP	0.0043 *	0.0727 *	-6.5725 *	**-4.8828 ***	-2.1016 *	88.21%
FinSen GBP	0.0041 *	0.0440 *	-5.5469 *	**-2.5256**	-2.3270 *	88.76%
CorpIG JPY	0.0005	0.0233 *	-1.9834 *	**1.5135**	-0.0181	52.94%
EMBIGlobDiv USD	0.0068 *	0.4277 *	-6.1187 *	**-13.4559**	0.2700	65.02%
CorpEM USD	0.0063 *	0.1415 *	-6.6163 *	**-10.2447 ***	-2.7170	84.50%
GNMAMortgages USD	0.0033 *	0.0252	-2.2574 *	**-0.4460**	1.7773	73.80%
ABS USD	0.0033 *	-0.0088	-1.6433 *	**1.5509**	0.2617	88.47%
CMBS USD	0.0040 *	0.0244	-5.0168 *	**-4.2089 ***	-0.5762	94.18%
Munis USD	0.0041 *	0.0400	-4.7615 *	**0.2392**	-2.8500 *	86.30%
HedgeFunds USD	0.0059 *	0.3555 *	-0.6151	**6.1686**	-5.5412 *	68.48%
Loans USD	0.0041 *	0.0702 *	0.0579	**-7.1272**	-6.4503 *	30.36%

NOTE: Table displays estimates of regressing bond index returns on factors in a seemingly unrelated regression framework according to $R_{i,t} = \alpha_i + \beta_i^{(1)} \Delta\text{Rates}_t + \beta_i^{(2)} \Delta\text{Default}_t + \beta_i^{(3)} \Delta\text{Liqui}_t + \beta_i^{(4)} R_t^{\text{MSCIw}} + \epsilon_{i,t}$; * indicates significance at the 95% level; inference is based on robust standard errors

Table A4: *Estimation Results using Liqui$_{Exact}$*

Sample			Coefficients of			
2005 M01 - 2007 M07	1	R_{MSCIw}	ΔRate	$\Delta\text{Liqui}_{\text{Exact}}$	$\Delta\text{Def}_{\text{Exact}}$	R^2
CorpIG USD	0.0213 *	0.0744 *	-5.7275 *	**-0.8327 ***	-4.4193 *	94.79%
HY US	0.0551 *	0.3227 *	-2.8209 *	**-2.6728 ***	-12.1879 *	65.34%
CorpIG EUR	0.0176 *	0.0259	-4.4180 *	**-0.9496 ***	-3.2667 *	89.03%
Collateralized EUR	0.0121 *	-0.0092	-4.7682 *	**-0.4956 ***	-2.2331 *	97.28%
FinSub EUR	0.0279 *	0.0429 *	-5.5666 *	**-1.8103 ***	-5.2305 *	92.45%
CorpIG GBP	0.0205 *	0.0853 *	-7.0732 *	**-1.2812 ***	-3.4347 *	91.64%
FinSen GBP	0.0172 *	0.0432 *	-4.9288 *	**-1.1722 ***	-2.5851 *	92.85%
CorpIG JPY	0.0008	0.0209	-2.5821 *	**0.0078**	-0.1401	70.49%
EMBIGlobDiv USD	0.0285 *	0.4151 *	-5.7872 *	**-2.6075**	-4.0704	68.36%
CorpEM USD	0.0397 *	0.2078 *	-6.2189 *	**-2.8268 ***	-7.0152 *	80.55%
GNMAMortgages USD	0.0063	0.0634 *	-3.2759 *	**0.1276**	-1.1092	85.71%
ABS USD	0.0037 *	0.0009	-1.5217 *	**0.5658 ***	-0.7967 *	91.84%
CMBS USD	0.0176 *	0.0280	-4.4675 *	**-0.4787**	-3.6744 *	92.63%
Munis USD	0.0142 *	0.0191	-3.4920 *	**-0.8309**	-2.0600 *	86.01%
HedgeFunds USD	-0.0031	0.4462 *	0.3609	**1.3103**	0.6481	68.68%
Loans USD	0.0511 *	0.0568	0.1376	**-3.2930 ***	-9.7385 *	75.78%

NOTE: Table displays estimates of regressing bond index returns on factors in a seemingly unrelated regression framework according to $R_{i,t} = \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_i^{(3)}\Delta\text{Liqui}_t + \beta_i^{(4)} R_t^{\text{MSCIw}} + \epsilon_{i,t}$; * indicates significance at the 95% level; inference is based on robust standard errors

Table A5: *Estimation Results using VIX control*

Sample			Coefficients of				
2002 M06 - 2008 M06	1	R_{MSCw}	ΔRate	$\Delta\text{Liqui}_{\text{PCA}}$	$\Delta\text{Def}_{\text{PCA}}$	ΔVIX	R^2
CorpIG USD	0.0035 *	0.0299	-5.5479 *	-4.8201 *	-4.7584 *	-0.0005 *	94.87%
HYUS USD	0.0061 *	0.1305 *	-1.9505 *	-8.4359 *	-7.4260 *	-0.0008	65.07%
CorpIG EUR	0.0034 *	-0.0153	-4.3301 *	-3.2304 *	-3.1964 *	-0.0003 *	93.13%
Collateralized EUR	0.0029 *	-0.0224 *	-4.5034 *	-1.1725 *	-1.0450 *	-0.0002	94.06%
FinSub EUR	0.0032 *	-0.0253	-5.4537 *	-6.7062 *	-6.9876 *	-0.0001	86.78%
CorpIG GBP	0.0037 *	0.0295	-6.4106 *	-4.2016 *	-4.5061 *	0.0001	91.49%
FinSen GBP	0.0037 *	-0.0013	-5.3825 *	-3.9500 *	-4.3919 *	0.0001	92.65%
CorpIG JPY	0.0004	-0.0053	-1.9601 *	-1.7895 *	-1.3810 *	0.0001	54.88%
EMBIGlobDiv USD	0.0074 *	0.2052 *	-6.2168 *	-6.0982 *	-5.1598 *	-0.0018 *	71.02%
CorpEM USD	0.0056 *	0.0621	-6.4196 *	-5.4707 *	-5.6821 *	-0.0006	84.94%
GNMAMortgages USD	0.0035 *	0.0367	-2.3358 *	0.2253	0.3713	0.0001	74.12%
ABS USD	0.0025 *	0.0059	-1.6483 *	-0.3370	-0.8491 *	0.0003	67.57%
CMBS USD	0.0032 *	0.0230	-4.7800 *	-2.3829 *	-2.3004 *	-0.0005	67.55%
Munis USD	0.0035 *	0.0133	-4.6461 *	-2.0507	-3.1134 *	-0.0004	59.56%
Hedge Funds USD	-0.0121	1.5728 *	-5.5158	7.2594	0.8680	0.0007	17.22%
Loans USD	0.0038 *	0.0188	-0.0553	-4.4400 *	-5.0430 *	-0.0003	52.05%

NOTE: Table displays estimates of regressing bond index returns on factors in a seemingly unrelated regression framework according to $R_{i,t} = \alpha_i + \beta_i^{(1)}\Delta\text{Rates}_t + \beta_i^{(2)}\Delta\text{Default}_t + \beta_i^{(3)}\Delta\text{Liqui}_t + \beta_i^{(4)} R_t^{\text{MSCIw}} + \beta_i^{(5)}\Delta\text{VIX} + \epsilon_{i,t}$; * indicates significance at the 95% level; inference is based on robust standard errors

Table A6: *Unrestricted coefficient estimates when analyzing impact of maturity*

Sample			Coefficients of			
2002 M06 - 2007 M07	1	R_{MSCIw}	ΔRate	$\Delta \mathrm{Liqui}_{\mathrm{PCA}}$	$\Delta \mathrm{Def}_{\mathrm{PCA}}$	R^2
Collaterlized 1-3 EUR	0.00297 *	-0.05603 *	-1.66037 *	-	-1.64706 *	59.08%
Collaterlized 3-5 EUR	0.00336 *	-0.06201 *	-3.79735 *	-	-2.35014 *	82.85%
Collaterlized 5-7 EUR	0.00380 *	-0.07630 *	-5.52925 *	-	-3.65759 *	87.67%
Collaterlized 7-10 EUR	0.00392 *	-0.04384 *	-7.04159 *	-	-3.14362 *	94.88%
Collaterlized 10+ EUR	0.00428 *	-0.06327 *	-9.21909 *	-	-5.69419 *	87.93%
FinSub A 1-3 EUR	0.00357 *	-0.05926 *	-1.80502 *	-	-1.87099 *	67.66%
FinSub AA 3-5 EUR	0.00359 *	-0.05356 *	-4.06300 *	-	-2.81903 *	85.20%
FinSub A 3-5 EUR	0.00379 *	-0.02836 *	-3.67663 *	-	-2.98730 *	85.26%
FinSub AA 5-7 EUR	0.00400 *	-0.06675 *	-5.20576 *	-	-3.80740 *	86.61%
FinSub A 5-7 EUR	0.00420 *	-0.03662 *	-6.66889 *	-	-4.23004 *	91.78%
FinSub BBB 5-7 EUR	0.00425 *	-0.05629 *	-5.29255 *	-	-4.38039 *	89.89%
FinSub AA 7-10 EUR	0.00387 *	0.01810	-6.66914 *	-	-4.76560 *	91.46%
FinSub A 7-10 EUR	0.00499 *	-0.00422	-4.68094 *	-	-5.91689 *	77.03%
FinSub BBB 7-10 EUR	0.00521 *	0.06408 *	-6.22146 *	-	-6.45621 *	73.22%
FinSub AA 10+EUR	0.00519 *	-0.08614 *	-7.96529 *	-	-5.25956 *	69.41%
FinSub A 10+ EUR	0.00420 *	-0.02449	-8.33776 *	-	-8.16946 *	86.84%
Corp AA 1-3 EUR	0.00306 *	-0.05202 *	-1.67476 *	-	-1.70360 *	59.74%
Corp A 1-3 EUR	0.00332 *	-0.04579 *	-1.66150 *	-	-1.80948 *	63.92%
Corp BBB 1-3 EUR	0.00320 *	-0.01569	-1.48943 *	-	-2.85984 *	65.70%
Corp HY 1-3 EUR	0.00747 *	0.25897 *	-0.71251	-	-5.88840 *	32.86%
Corp AA 3-5 EUR	0.00370 *	-0.06278 *	-3.68829 *	-	-2.24749 *	82.21%
Corp A 3-5 EUR	0.00378 *	-0.04747 *	-3.49900 *	-	-2.83948 *	84.38%
Corp BBB 3-5 EUR	0.00328 *	0.00786	-3.22082 *	-	-3.67851 *	74.76%
Corp HY 3-5 EUR	0.00924 *	0.34871 *	-1.26397	-	-3.71927	31.72%
Corp AA 5-7 EUR	0.00409 *	-0.06743 *	-5.35961 *	-	-3.59311 *	88.81%
Corp A 5-7 EUR	0.00429 *	-0.04154 *	-5.17248 *	-	-4.25199 *	89.58%
Corp BBB 5-7 EUR	0.00381 *	0.01194	-4.75219 *	-	-5.09573 *	87.06%
Corp HY 5-7 EUR	0.00196	0.77399 *	-2.57898	-	-12.63393 *	41.96%
Corp AA 7-10 EUR	0.00424 *	-0.03011 *	-6.70830 *	-	-2.87239 *	94.82%
Corp A 7-10 EUR	0.00456 *	0.00695	-9.45509 *	-	-3.47227 *	95.41%
Corp BBB 7-10 EUR	0.00430 *	0.00402	-6.30401 *	-	-4.10425 *	94.13%
Corp HY 7-10 EUR	0.00532 *	0.06520 *	-9.02943 *	-	-3.36937 *	84.11%
Corp AA 10+ EUR	0.00498 *	0.00015	-6.09835 *	-	-5.56044 *	81.34%
Corp BBB 10+ EUR	0.00534	0.46189 *	-3.01324	-	-14.92849 *	36.91%

NOTE: * indicates significance at the 95% level; inference is based on robust standard errors.

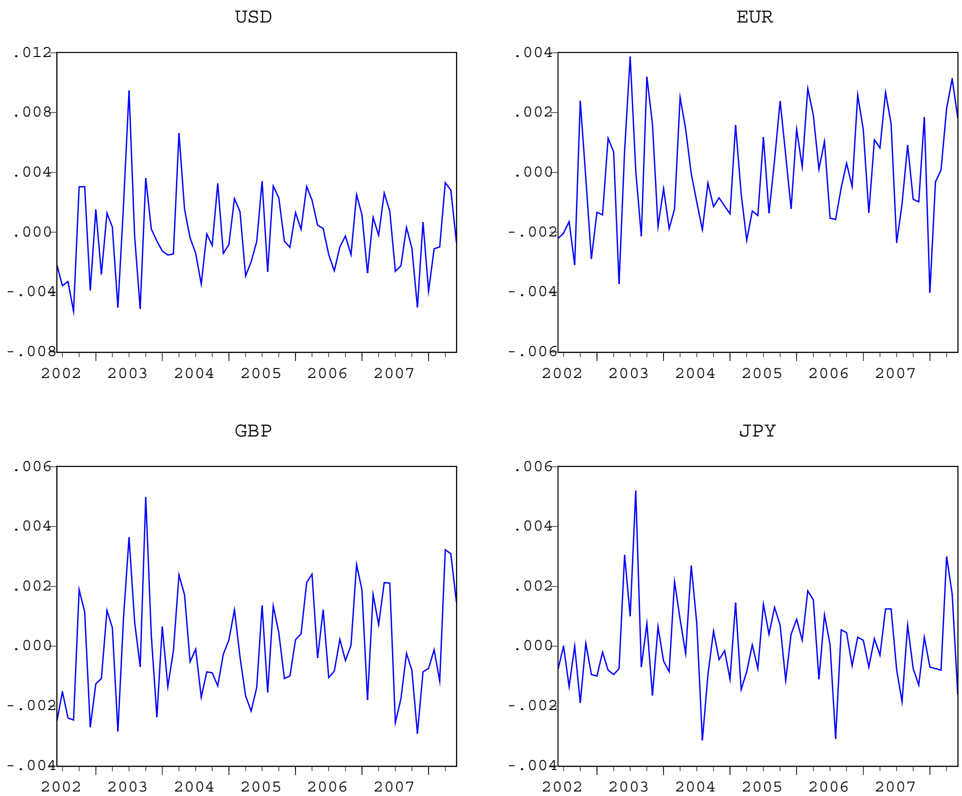

Figure A1: *Government yield changes for US Dollar, Euro, British Pound, and Yen*

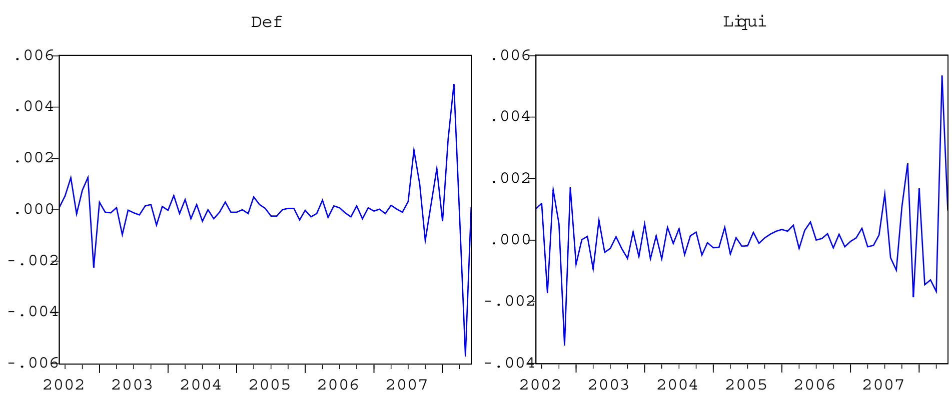

Figure A2: *Changes in the default and liquidity measures*

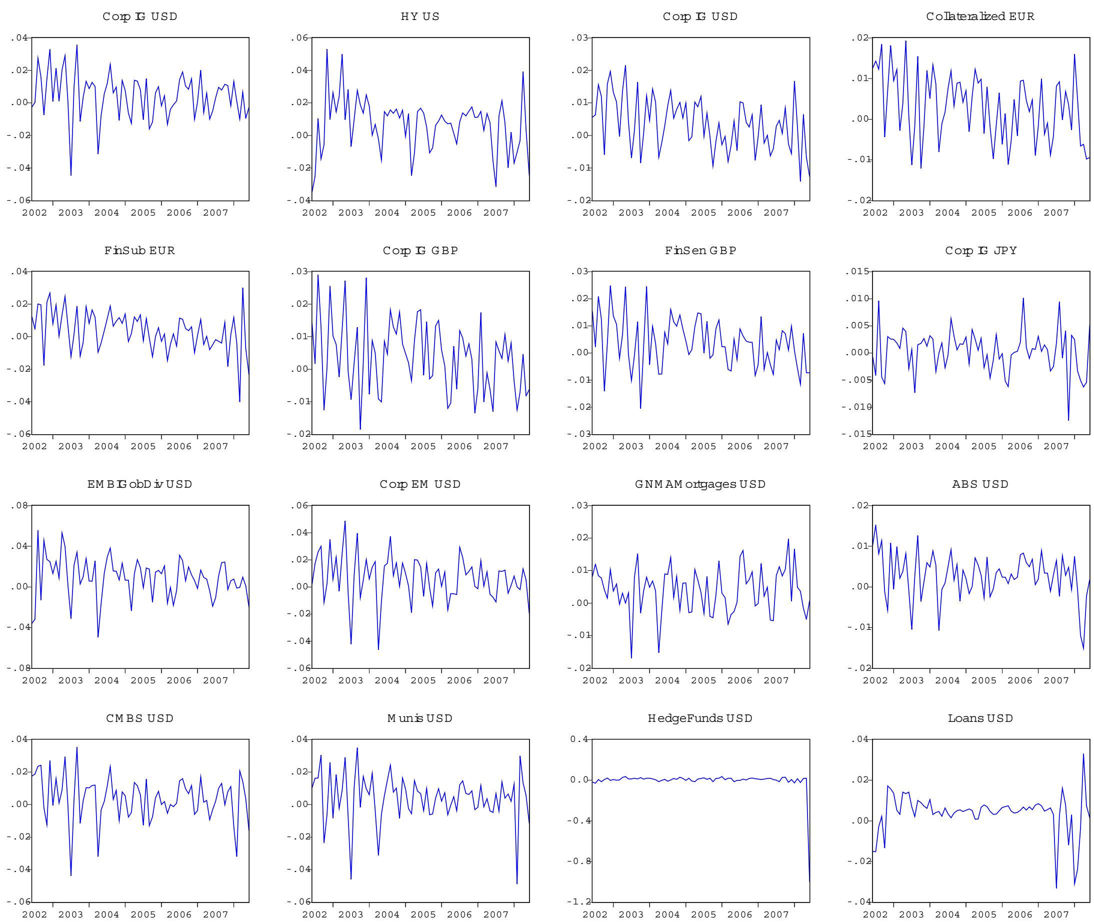

Figure A3: *Returns on the bond indices*