“Yield spreads, value of bonds, and implications for liquidity management - an empirical analysis during the crisis”

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ARTICLE INFO	Mario Strassberger (2012). Yield spreads, value of bonds, and implications for liquidity management - an empirical analysis during the crisis. *Investment Management and Financial Innovations*, *9*(2-1)
RELEASED ON	Tuesday, 31 July 2012
JOURNAL	"Investment Management and Financial Innovations"
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

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Yield spreads, value of bonds, and implications for liquidity management – an empirical analysis during the crisis

Abstract

Given the sharp increase of bond yield spreads and the considerable losses to the value of bond portfolios during the recent financial market crisis, the reliable estimation of haircuts on bond values has become increasingly important. The banking supervisors motivate this too, when they demand institutes to hold an adequate level of liquidity. This paper analyzes different data sets of Bloomberg Fair Market Curves of different sectors, credit qualities, and maturities for deducing spreads and haircuts. Starting with a regular market environment, the analysis shows a clear ex ante underestimation of spreads as well as haircuts. The analysis indicates evident rises in average spreads, e.g., up to 13 times for one-year maturities even for AAA securities. In the crisis situation there are haircuts of up to 35% even for investment grade bonds. Financial institutes have to take into consideration these findings for a reliable liquidity management.

Keywords: bond value, financial market crisis, haircuts, liquidity, risk management, yield spreads.
JEL Classification: C10, G10.

Introduction

Due to the sharp increase of bond yield spreads in the market during the recent financial market crisis[1], financial institutes faced considerable losses to the value of their bond portfolios. These losses were significant as institutes typically hold such portfolios as a means of liquidity reserve and to assure refinancing with the European Central Bank (ECB). The reliable estimation of haircuts on bond values has become increasingly important, given this background and together with the newly published requirements and recommendations for liquidity risk management of the banking supervision[2]. The maintenance of an adequate level of liquidity by financial institutes is one of the key demands of the guidance of the Basel Committee. Liquidity and liquidity risk thereby always mean the ability of the institute to meet its financial obligations. But, what means “adequate” in the context of holding a liquidity reserve, especially under the circumstances of the financial market crisis? We put this question into the center of the following analysis. The paper contributes to the literature by providing an estimation technique of haircuts on the values of bonds which helps investors to rightly calculate its liquidity reserves. The risk of increasing refinancing cost as a result of rising spreads in the market is another important problem which is not on the agenda of this analysis[3].

The paper is organized as follows. Section 1 provides the empirical data and its most important statistic characteristics. The design of our analysis is outlined in section 2, and the main results are presented in section 3. Conclusions and implications for liquidity management are drawn in the final section.

1. Empirical data and statistics

For deducing bond yield spreads and haircuts we analyze Bloomberg Fair Market Curves for different sectors, credit qualities, and maturities. Fair Market Curves are yield curves synthetically derived from a universe of all debt securities of a certain sector. On a daily basis there is constructed an unambiguous and distortion-free curve[4]. Because we are interested in liquidity maintenance we just regard the four credit qualities AAA, AA, A and BBB or rating classes, respectively. Further, we choose the EUR Composite curves. These curves cover all EUR emissions of publics, corporates and financials (AAA includes German Pfandbriefe) mainly from within the European Union (EU), but also EUR emissions of such borrowers outside the EU. Further, we examine the following yields to maturity as supporting points of the curves (Y = year): 1Y, 3Y, 5Y, 7Y, 10Y, 15Y, and 20Y. The benchmark is the Bloomberg Fair Market Government Curve at these maturities which is assumed to be appropriate to proxy the risk free rates[5]. Bonds with a maturity of 20 or more years are issued relatively seldom. The curves might be extrapolated at these intervals[6].

We use two data sets for our analysis. Set 1 indicates the out-of-crisis sample. It is running from January 1, 2004 up to July 31, 2007, the beginning of the financial market crisis. Set 1 covers 1,308 observations. Set

The paper was presented at the VII Annual International Conference “International Competition in Banking: Theory and Practice” (May 24-25, 2012, Sumy, Ukraine).
The paper was refereed by the Conference Scientific Committee using double-blind review.

[1] See, e.g., Brunnermeier (2009) for an overview of the beginning crisis.
[2] See Basel Committee on Banking Supervision (2008), Basel Committee on Banking Supervision (2010), and Committee of European Banking Supervisors (2008) among others.
[3] This is discussed by Bartetzky, Gruber, and Wehn (2008), with a focus on liquidity spreads.

[4] See Bloomberg (2007).
[5] At the latest from the beginning of the EUR currency crisis (2010) this assumption might not apply.
[6] Implications of an extrapolation are discussed further on (see Table 9).

2 is running from August 1, 2007 up to December 31, 2010, thus including the crisis. The in-crisis sample covers 1,249 observations.

First, we derive some descriptive statistics of the data. The following Tables 1 and 2 show the two parameters sample expectation (E) and sample standard deviation (Sd) of the two data sets. We see normal yield structures on average in all cases. Yields rise in both dimensions, the increasing time to maturity and the decreasing credit quality. Whereas the government yields decreased on average with the beginning of the crisis, all other bond yields increased on average. Government yields reduced between 80 basis points at the short term and 20 basis points at the 10Y maturity, thus the government curve became much steeper. Reasons for this are the higher uncertainty in the financial system and investor's flight-to-quality behavior. Bond yields on lower credit classes raised the more the poorer the credit quality and the longer the time to maturity, i.e. up to 130 basis points for BBB and 20Y. The standard deviations of the yields mostly increased after the beginning of the crisis. Especially short-term yield's standard deviations have doubled[1]. This again is an expression of the clear increase of uncertainty in the market environment.

Table 1. Sample parameters of bond yields in Set 1 in %

		1Y	3Y	5Y	7Y	10Y	15Y	20Y
Gov	E Sd	2.83 0.79	3.16 0.61	3.43 0.49	3.63 0.42	3.84 0.38	4.09 0.39	4.20 0.41
AAA	E Sd	2.95 0.77	3.33 0.62	3.62 0.51	3.82 0.45	4.05 0.42	4.29 0.41	4.52 0.40
AA	E Sd	3.00 0.77	3.40 0.62	3.68 0.51	3.88 0.46	4.14 0.42	4.44 0.39	4.63 0.42
A	E Sd	3.07 0.76	3.50 0.61	3.82 0.51	4.04 0.45	4.33 0.42	4.68 0.40	4.88 0.44
BBB	E Sd	3.21 0.71	3.73 0.56	4.14 0.47	4.42 0.43	4.79 0.39	5.19 0.32	5.53 0.28

Table 2. Sample parameters of bond yields in Set 2 in %

		1Y	3Y	5Y	7Y	10Y	15Y	20Y
Gov	E Sd	2.02 1.57	2.48 1.18	2.95 0.89	3.29 0.70	3.62 0.56	4.03 0.49	4.20 0.47
AAA	E Sd	2.86 1.51	3.39 1.06	3.80 0.83	4.09 0.68	4.39 0.57	4.64 0.52	4.65 0.37
AA	E Sd	3.08 1.39	3.53 1.03	3.97 0.80	4.29 0.67	4.65 0.57	4.84 0.45	4.93 0.44
A	E Sd	3.39 1.39	3.88 1.05	4.34 0.90	4.66 0.77	5.06 0.65	5.33 0.69	5.28 0.55
BBB	E Sd	3.77 1.44	4.44 1.18	5.02 1.10	5.44 1.02	5.91 1.05	6.38 0.83	6.84 0.89

All time series of the bond yields of data Set 1 and data Set 2 are plotted in Figure 3 and Figure 4 in the Appendix. To illustrate the clear change of the bond yields with the beginning of the financial market crisis an example of the whole time series is given in Figure 1 for the 1Y maturity.

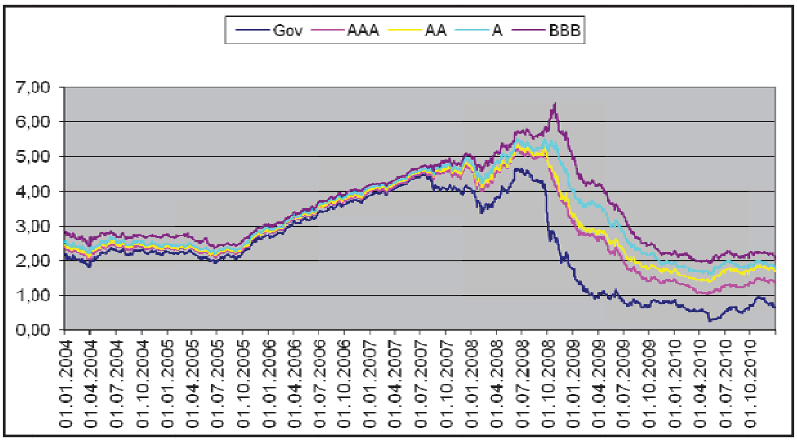

Fig. 1. Bond yields at maturity 1Y (Set 1 + Set 2)

[1] See Gefang, Koop, and Potter (2011) for very similar findings.

Further, bond yield spreads are calculated as follows. The observed yield spread s_t at time t is defined as the difference between the yield of the respective EUR Fair Market Composite Curve, r_t^{comp}, and the yield of the Fair Market Government Curve, r_t^{gov}, at that time[1]

$$s_t = r_t^{comp} - r_t^{gov}. \qquad (1)$$

It is not necessary to distinguish the credit spread and the liquidity spread in the market for our purposes[2]. The source of a haircut is immaterial in view of the value of a bond portfolio from the perspective of maintaining a certain liquidity level.

The following Tables 3 and 4 show the two parameters sample expectation (E) and sample standard deviation (Sd) of the bond yield spreads. Before the financial market crisis we see normal spread structures on average. As well as the bond yields, the corresponding yield spreads rise in both dimensions, the increasing time to maturity and the decreasing credit quality. Within the crisis we find a tremendous raise in yield spreads on average. Together with the steeper benchmark government curve, yield spreads are six-fold higher than before the crisis especially at the short term. Yield spreads raised the more the better the credit quality and the shorter the time to maturity. Altogether, the yield spread curves show an inverse structure on average. Again, the increase of uncertainty and the flight to quality become eminently clear. The standard deviations of the yield spreads rose tremendously, too. Standard deviations were tenfold especially in the short term.

Table 3. Sample parameters of bond yield spreads in Set 1 in basis points

		1Y	3Y	5Y	7Y	10Y	15Y	20Y
AAA	E Sd	12.14 3.96	16.81 1.77	18.94 3.64	18.59 3.10	21.36 5.06	20.10 4.52	31.36 5.00
AA	E Sd	17.08 4.04	24.03 3.92	25.38 5.43	25.28 4.77	29.85 6.15	35.61 4.44	42.32 10.04
A	E Sd	23.72 5.38	34.41 4.85	39.00 6.20	40.72 5.35	48.86 7.71	59.77 10.76	67.92 9.99
BBB	E Sd	38.25 11.63	57.39 12.99	70.93 12.32	78.87 8.76	94.61 9.34	110.20 16.21	132.63 34.43

Table 4. Sample parameters of bond yield spreads in Set 2 in basis points

		1Y	3Y	5Y	7Y	10Y	15Y	20Y
AAA	E Sd	83.69 39.27	90.72 31.16	85.04 30.36	79.33 27.54	76.93 27.14	60.58 20.93	44.78 13.79
AA	E Sd	106.24 41.20	104.42 35.38	102.70 34.96	99.47 34.14	102.88 34.80	80.43 23.76	73.54 18.17
A	E Sd	136.78 62.01	140.12 55.36	139.22 56.33	136.98 54.64	143.36 51.90	129.46 51.02	108.46 31.67
BBB	E Sd	174.83 81.63	195.51 81.70	207.48 88.14	215.24 91.27	229.09 97.48	234.73 77.74	264.14 82.03

All time series of the bond yield spreads of data Set 1 and data Set 2 are plotted in Figure 5 and Figure 6 in the Appendix. An example of the whole time series is given in Figure 2 for the 1Y maturity to illustrate the tremendous widening of the yield spreads with the beginning of the financial market crisis.

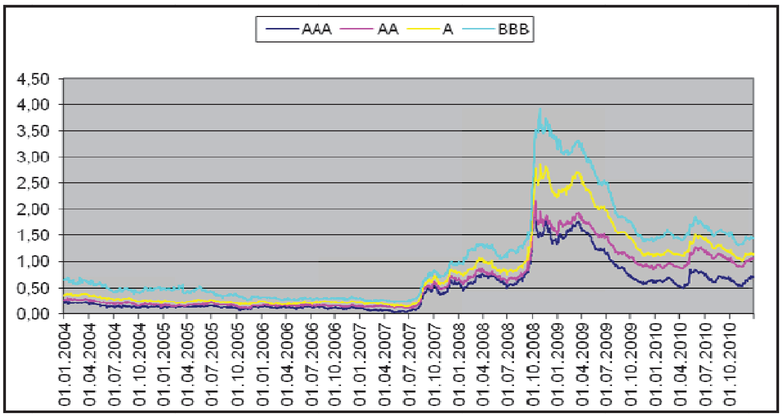

Fig. 2. Bond yield spreads at maturity 1Y (Set 1 + Set 2)

[1] See, e.g., Elton, Gruber, Brown, and Goetzmann (2007), p. 530.
[2] See Dionne, Gauthier, Hammami, Maurice, and Simonato (2010), Gefang, Koop, and Potter (2011), or Baglioni (2012), for that differentiation.

We compute the higher third and fourth moments to get an explicit look at the distribution characteristics of the observed yield spreads. Table 5 shows the sample skewness and the sample kurtosis of the yield spreads over all credit qualities and times to maturity. Parameters suggest that the spread distributions would be closer to a symmetric and nearly normal distribution before the crisis. This is because both parameters are nearer to zero in Set 1. Instead of this, spreads are distributed definite right skewed and sharper or heavy tailed, respectively, in Set 2[1].

Table 5. Higher sample parameters of bond yield spreads

	Data Set 1	Data Set 2
Skewness	0.3553	0.8398
Kurtosis	-0.0114	0.1462

As the probability distribution of the bond yield spreads has changed with the occurrence of the crisis the use of regime-switching models might be promising.

2. Design of the analysis

Assuming independent and normally distributed yield spreads under regular market conditions[2] we estimate expected spreads as well as p-quantiles of the respective spread distribution over all credit qualities and times to maturity in Set 1. Using this quantiles, a financial institute could calculate yield spread expansions on a certain probability level which is adequate to its rating class, e.g. $p = 0.9999$ for an AAA rating. Instead of this, we next identify the maximum observed yield spreads during the crisis for all credit qualities and times to maturity in Set 2.

Further, we calculate the relative changes in value of zero bonds once based on expected spread expansions and once based on maximum spread expansions. For that purpose, we determine the present value PV_t of a zero coupon bond (simplified perception) once using the reference yield of the government curve, r_t^{gov}, plus the expected spread, s_t^{exp}, and once using the reference yield of the government curve plus the maximum observed spread, s_t^{max}, for each rating class and time to maturity[3].

$$PV_t^{exp} = \frac{1}{\left(1 + r_t^{gov} + s_t^{exp}\right)^t}, \tag{2}$$

$$PV_t^{max} = \frac{1}{\left(1 + r_t^{gov} + s_t^{max}\right)^t}. \tag{3}$$

Spreads on yields to maturity and spreads on spot rates might differ. However, for data reasons spreads are computed from yields to maturity here. We are interested in the necessary value of a bond portfolio securing an adequate level of liquidity. Finally, we interpret the relative change in the zero bond's present value caused by the expansion of yield spreads as the haircut H_t on that bond.

$$H_t = \frac{PV_t^{max} - PV_t^{exp}}{PV_t^{exp}}. \tag{4}$$

Studying zero coupon bonds leads to a kind of upper bound for haircuts on bond values. The haircuts of fixed coupon bonds are throughout lower than those of zeros.

3. Main results

First, we consider Set 1. The expected yield spreads under "normal" conditions are reported in Table 6. In Table 7 we report the 99.99%-quantile of the spread distributions which we estimated with the respective parameters for each rating class and maturity.

Table 6. Expected yield spreads in basis points

	1Y	3Y	5Y	7Y	10Y	15Y	20Y
AAA	12.14	16.81	18.94	18.59	21.36	20.10	31.36
AA	17.08	24.03	25.38	25.28	29.85	35.61	42.32
A	23.72	34.41	39.00	40.72	48.86	59.77	67.92
BBB	38.25	57.39	70.93	78.87	94.61	110.20	132.63

Table 7. 99.99%-quantile of the yield spread distributions in basis points

	1Y	3Y	5Y	7Y	10Y	15Y	20Y
AAA	26.86	23.41	32.46	30.13	40.19	36.92	49.96
AA	32.10	38.60	45.56	43.01	52.72	52.11	79.65
A	43.73	52.44	62.05	60.61	77.52	99.78	105.08
BBB	81.49	105.69	116.76	111.51	129.35	170.48	260.66

Second, we consider Set 2. The maximum observed yield spreads during the financial market crisis are reported in Table 8.

Table 8. Maximum observed yield spreads in basis points

	1Y	3Y	5Y	7Y	10Y	15Y	20Y
AAA	200.60	156.50	299.40	144.10	142.90	121.90	75.20
AA	215.60	174.80	320.90	183.70	195.00	144.65	137.98
A	285.00	267.80	335.20	265.00	272.00	266.40	214.90
BBB	391.08	398.50	412.60	432.20	461.20	403.30	444.40

Comparing the resulting yield spread data of Set 1 (Tables 6 and 7) with those of Set 2 (Table 8) shows throughout an evident rise in yield spreads. Especially in the short term of the yield curves there are

[1] See Campbell, Lo, and MacKinlay (1997, p. 16f).
[2] See, e.g., Fabozzi, Neave, and Zhou (2012, p. 376f). If we would use spot rate spreads instead of yield spreads (see equations 2 and 3) spot rate spreads might be normally distributed. Under this condition the yield spreads are not normally but lognormally distributed.
[3] See, e.g., Uhlir, and Steiner (2001, p. 63).

the most significant expansions from what one would have expected before the crisis to the observed maximum within the crisis, e.g. up to 13 times for one-year maturities for AAA securities. Thus, the increase in yield spreads was mainly driven by liquidity premiums rather than credit premiums[1]. Market participants lost their confidence in bond issuers resulting in an open supply of debt securities. Starting with a regular market environment as basis, the analysis indicates a clear ex ante underestimation of yield spreads. The yield spreads that actually appeared in the financial market crisis were clearly much higher than one would have expected before, even with a confidence of 99.99%.

Finally, the calculated haircuts on the present value of zero coupon bonds according to equation (4) are reported in Table 9.

Table 9. Haircuts on zero bonds in %

	1Y	3Y	5Y	7Y	10Y	15Y	20Y
AAA	-1.04	-2.55	-8.91	-5.96	-8.40	-10.37	-6.01
AA	-1.09	-2.75	-9.36	-7.45	-11.22	-11.05	-12.62
A	-1.43	-4.21	-9.37	-10.35	-14.81	-19.80	-18.65
BBB	-1.92	-6.07	-10.69	-15.72	-22.98	-26.73	-35.17

Haircuts rise in both dimensions, the decreasing credit quality and the increasing time to maturity. The extrapolation of the Fair Market Composite Curves for long-term maturities could lead to an overestimation of bond yield spreads and haircuts at those maturities, such as 20Y. But, nevertheless, one would clearly underestimate haircuts if one would calculate with "normal" yield spreads under regular market conditions. In the crisis situation we already see haircuts of more than 20% for investment grade bonds, in some cases even more than 35%. Financial Institutes must consider these findings in proportioning an "adequate" liquidity reserve.

Conclusions

The results of the analysis demonstrate the increasing importance to minimize estimation errors of haircuts on the value of bonds for liquidity management. If we account for the lessons of the financial market crisis maintaining an adequate level of liquidity by financial institutes means not only to hold portfolios of high liquid securities. Depending on credit quality and maturity structure of those portfolios financial institutes may have to keep up to one fifth more in current market value of bonds to assure liquidity during a market crisis, too. Thus, institutes should estimate their individual additional charge on liquidity reserve to provide for solvency in extreme situations.

However, the highest haircuts would not necessarily be realized if the institute holds securities transferable to the ECB. The institute would first use secured refinancing with the ECB at probably lower haircuts before liquidating securities on the market.

The recent financial market crisis has shown another aspect. A liquidity shock in financial markets could persist for several months. If we want the liquidity reserve to be sufficient we possibly have to put an additional discount on actual market value to ex ante account for the occurrence of a crisis. This might be subject to further research.

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[1] See also Gefang, Koop, and Potter (2011), or Baglioni (2012) for this interpretation.

Appendix

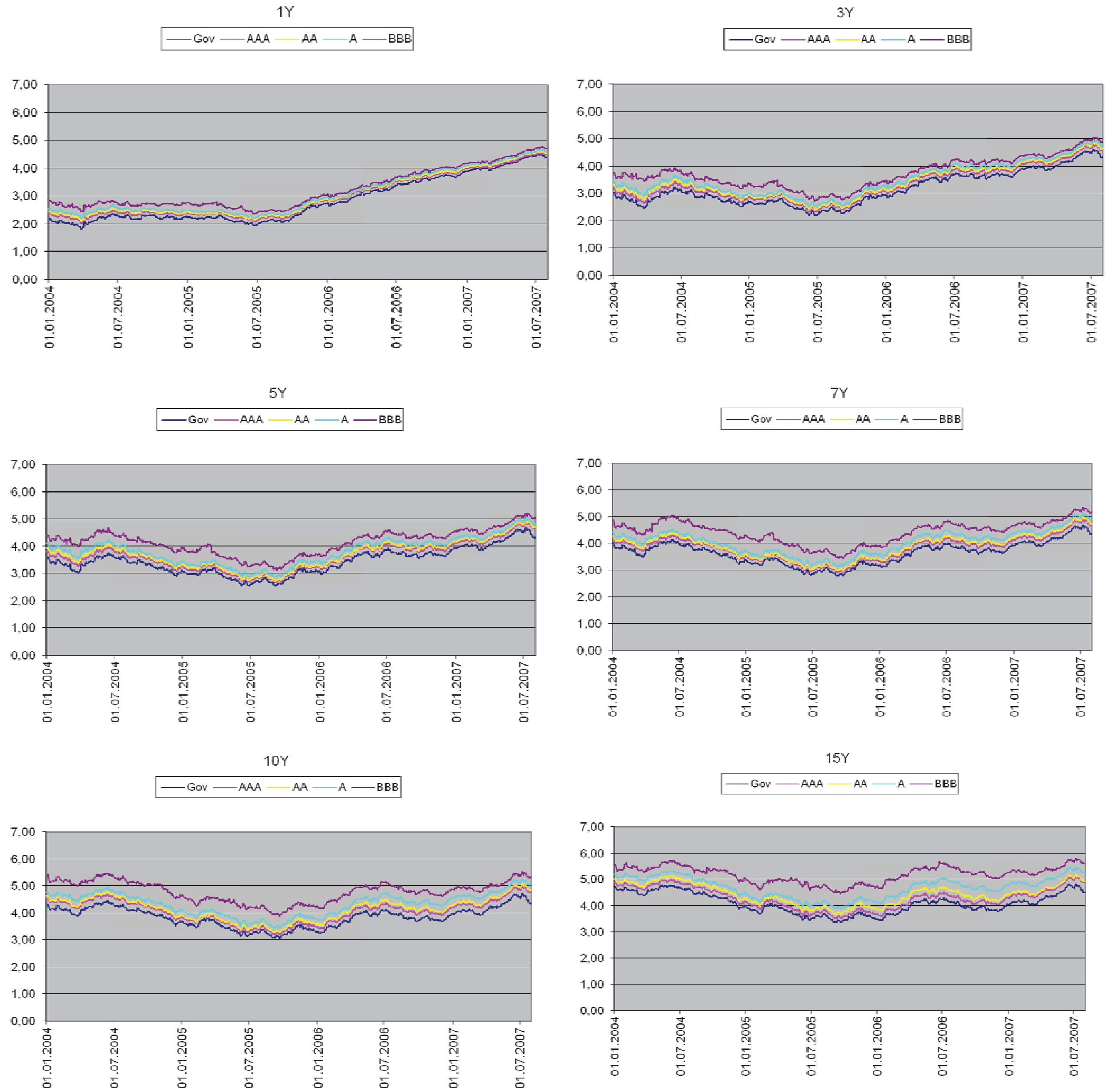

Fig. 3. The plot of time series of bond yields before the crisis (Set 1)

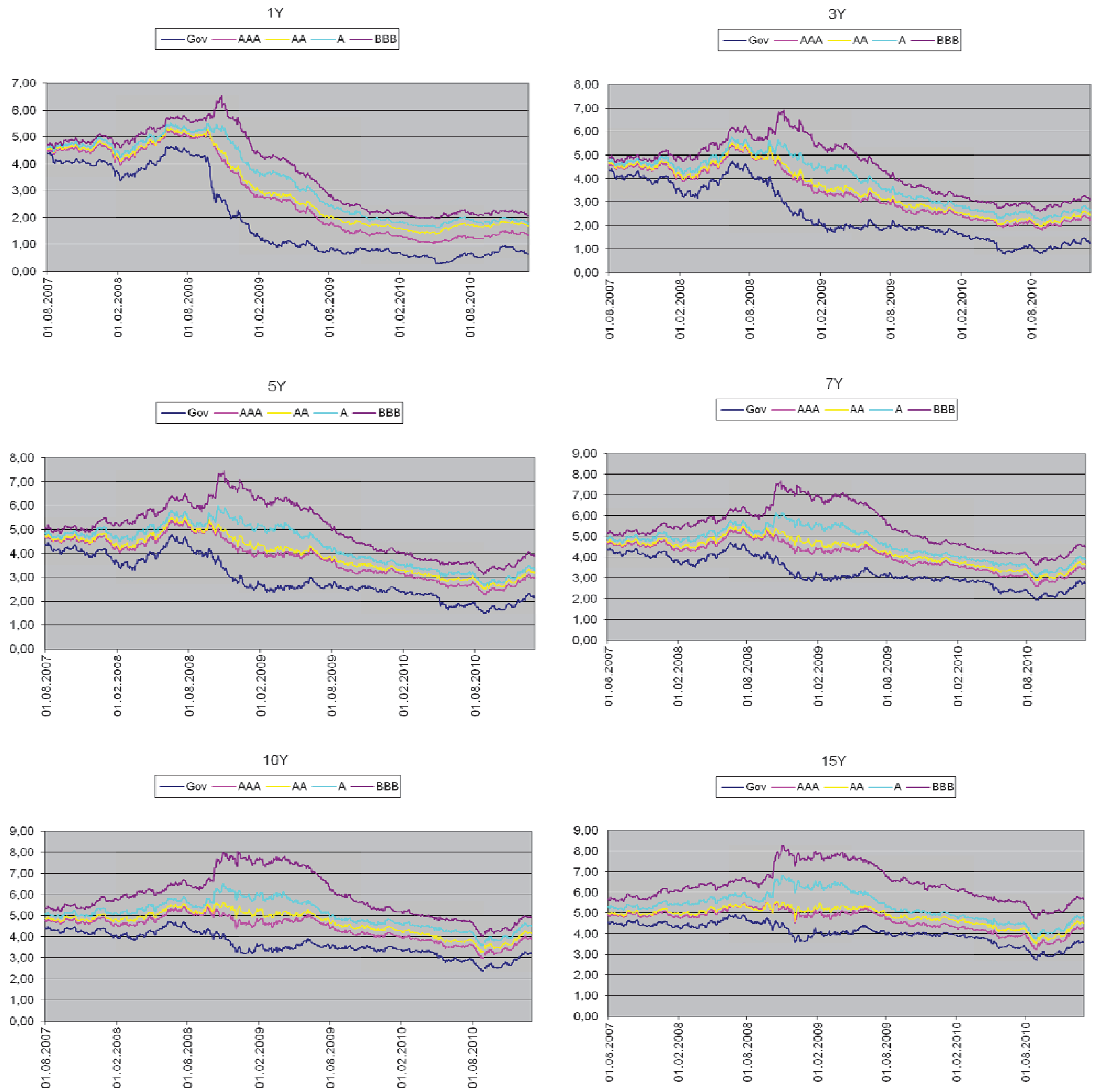

Fig. 4. The plot of time series of bond yields within the crisis (Set 2)

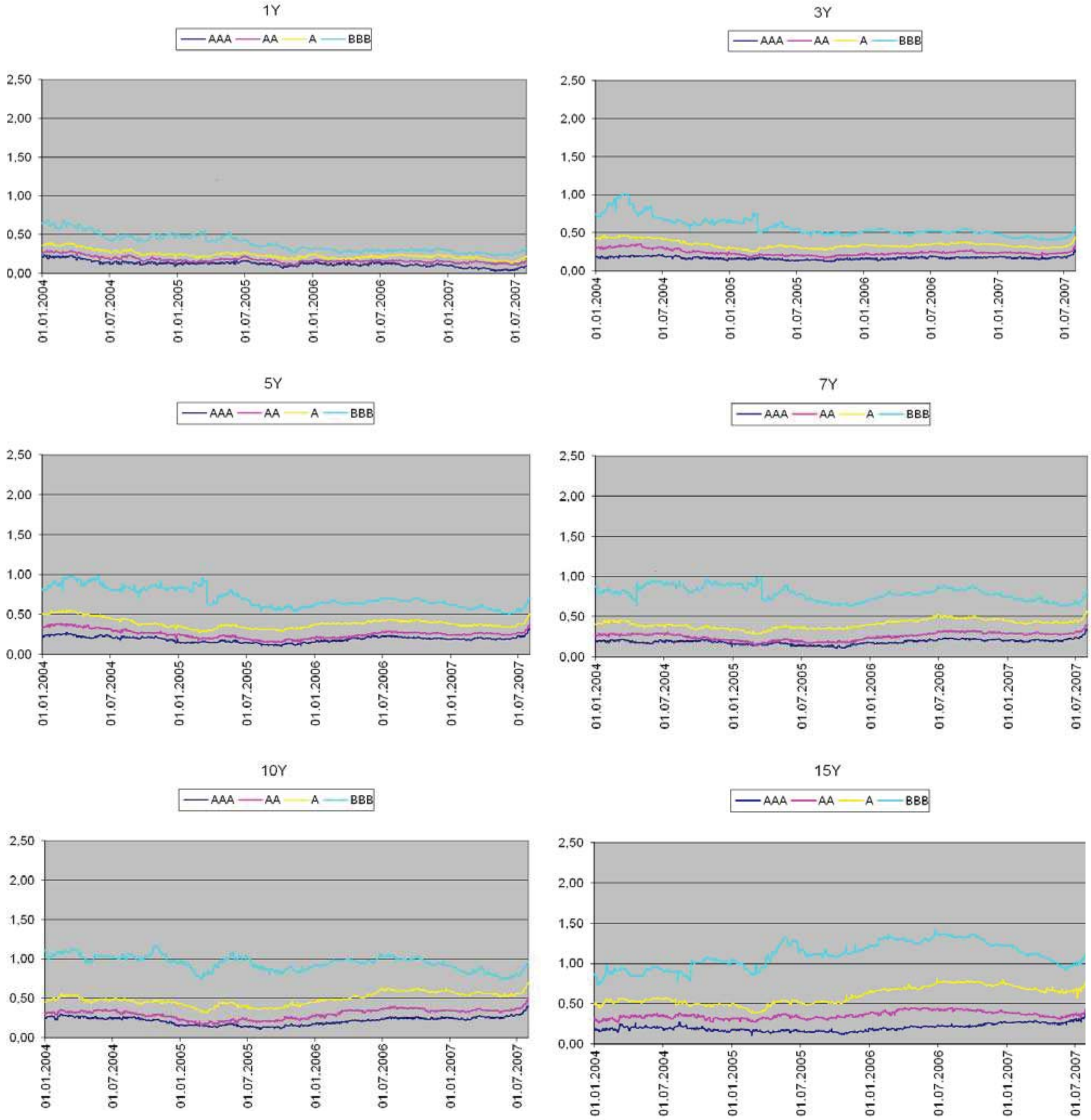

Fig. 5. The plot of time series of yield spreads before the crisis (Set 1)

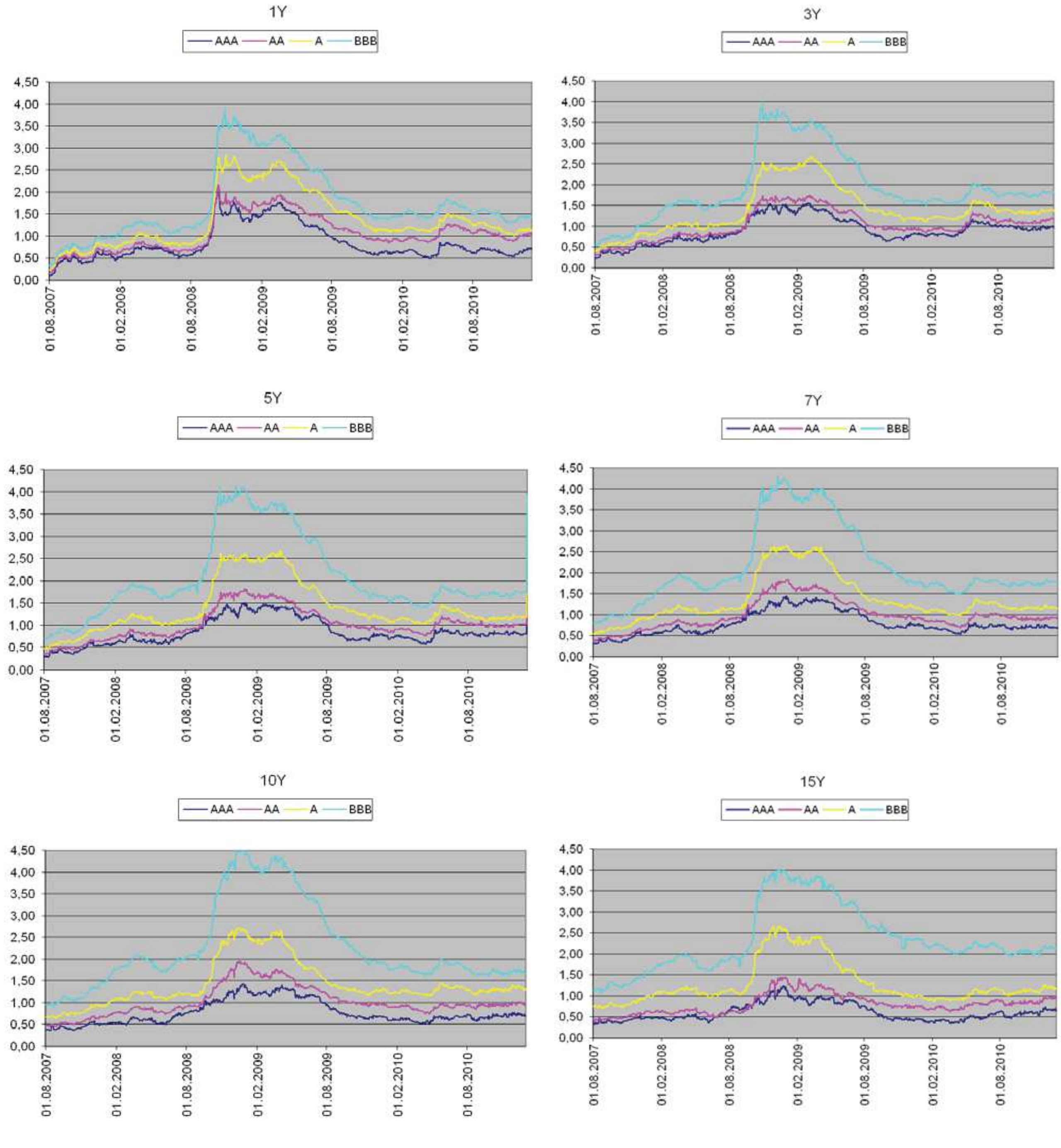

Fig. 6. The plot of time series of yield spreads within the crisis (Set 2)