The impact of credit rating changes on bond prices in South Africa

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ABSTRACT

The study inquires whether ratings and rating changes in particular have any impact on bond prices. In doing so, the price data of a number of corporate vanilla bonds were investigated over corresponding rating change event periods.

For various reasons, the South African Bond Market could not deliver a large sample of plain vanilla bonds that experienced a rating change. Therefore, to complement the study's main sample, a small sample of callable corporate vanillas was also studied. In both cases the eventual sample sizes necessitated an investigation based on single issues. Neither of the samples contained "serious" rating changes; the lowest rating studied was of lower-medium investment grade quality and none of the rating changes was by more than one notch.

Stationarity and unit-root tests were conducted on the non-callable and callable issues' individual price series to determine whether the issues experienced significant price impacts in response to their respective rating-change announcements. Based on the test-results, only a number of non-callable issues experienced significant impacts. The number shrunk considerably after contamination could be proven in some cases, and when the directions of the yield spread movements were taken into consideration. An even smaller number of callable issues registered significant impacts. Contamination was not that customary in the case of callable issues, but direction of movement still played a role.

Overall, out of the ten non-callable issues, none appear to have been impacted by their respective rating changes; out of the nine callable bonds, only one may have been impacted by a rating change, conditional on the issue's call option. In some cases the rating changes were preceded by rating warnings – whether rating outlooks or rating watches; the study did not investigate whether the market responded to these warnings.

The study also concludes that issue-specific characteristics play an important role in determining whether ratings can potentially impact prices. With regards to this –

Time-to-Maturity is a good example. Additionally, it appears as if rating data should be a lot more issue-based - as opposed to being issuer-based - in order to be of any use, at least in the case of bonds that is.

Under the Literature Review, enormous attention is paid to bond price determinants, the impact thereof on credit ratings, and thus the resultant ability of credit ratings to impact bond prices. The review manages to unravel the correlation between credit ratings and bond prices, to some extend. In addition, the study offers new insights into the pricing of risky bonds, particularly through an alternative modelling of default losses.

DECLARATION

I, Brian Barnard, declare that this research report is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name

Date

DEDICATION

To Burnan Barnard…

ACKNOWLEDGEMENTS

A special thanks to Tertius Smith (Fitch Ratings), Numsa Nkuhlu (Fitch Ratings), Marie du Plooy (Fitch Ratings), and Jacob Shayi (BESA) for their valuable assistance with data core to the study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DEFINITION OF TERMS

The terms listed below are truly not new; they are mostly included to assist users not too familiar with bond credit ratings…

Across-rating-grade/ within rating grade	An indication whether the rating announcement implies a shift between investment grade and speculative grade (across rating grade) or not (within rating grade); see Table 1 for a list of possible ratings.
BESA	Bond Exchange of South Africa
Bond Rating	A corporate issuer credit rating; broadly defined as an indication of creditworthiness and assigned to a bond-issuer or –issue by a rating agency; see Table 1 for a list of possible ratings.
Investment grade	Refers to ratings equal to or above BBB- (Baa3); see Table 1 for a list of possible ratings.
Rating Action	“In general, only credit quality changes that are believed to be permanent should result in a credit rating action.” (Hamilton and Cantor 2004:54)
Rating Outlook	An indication that a change in the risk profile (of the issuer/ issue) has been observed, but its permanence has not yet been established (Hamilton and Cantor 2004). “A Moody’s rating Outlook is an opinion regarding the likely direction of a rating over the medium term, typically eighteen to thirty-six months...” (Hamilton and Cantor 2004:5)

Rating Review	When it is believed that a permanent change in risk has indeed occurred, the issuer is placed on review for a rating change. When the remaining uncertainty is resolved, the rating is either changed or confirmed (Hamilton and Cantor 2004). A rating under review (RUR) designation indicates that the issuer has one or more ratings under review for a possible change and thus overrides the outlook designation (Altman and Rijken 2006).
Speculative grade	Refers to ratings below BBB- (Baa3); see Table 1 for a list of possible ratings.
Split rating	Occurs when two or more independent credit rating agencies assign different ratings to the same bond (or issuer); two or more credit rating agencies rate the same bond (or issuer), but assign different ratings to it.
Watchlist	"Moody's uses the Watchlist to indicate that a rating is under review for possible change in the short term, usually within ninety days.... A credit is removed from Watchlist when the rating is upgraded, downgraded or confirmed." (Altman and Rijken 2006:5)

Table 1. Agency Credit Ratings[1]

<table>
<tr><th colspan="2">Moody’s*</th><th colspan="2">S & P*</th><th colspan="2">Fitch*</th><th colspan="2">CA Ratings**</th><th></th></tr>
<tr><td>Long Term</td><td>Short Term</td><td>Long Term</td><td>Short Term</td><td>Long Term</td><td>Short Term</td><td>Long Term</td><td>Short Term</td><td></td></tr>
<tr><td>Aaa</td><td rowspan="6">P-1</td><td>AAA</td><td rowspan="4">A1+</td><td>AAA</td><td rowspan="4">A1+</td><td>AAA</td><td rowspan="4">A1+</td><td>Prime</td></tr>
<tr><td>Aa1</td><td>AA+</td><td>AA+</td><td>AA+</td><td rowspan="3">High Grade</td></tr>
<tr><td>Aa2</td><td>AA</td><td>AA</td><td>AA</td></tr>
<tr><td>Aa3</td><td>AA-</td><td>AA-</td><td>AA-</td></tr>
<tr><td>A1</td><td>A+</td><td rowspan="2">A1</td><td>A+</td><td rowspan="2">A1</td><td>A+</td><td rowspan="2">A1</td><td rowspan="3">Upper Medium Grade</td></tr>
<tr><td>A2</td><td>A</td><td>A</td><td>A</td></tr>
<tr><td>A3</td><td rowspan="2">P-2</td><td>A-</td><td rowspan="2">A2</td><td>A-</td><td rowspan="2">A2</td><td>A-</td><td rowspan="2">A2</td></tr>
<tr><td>Baa1</td><td>BBB+</td><td>BBB+</td><td>BBB+</td><td rowspan="3">Lower Medium Grade</td></tr>
<tr><td>Baa2</td><td rowspan="2">P-3</td><td>BBB</td><td rowspan="2">A3</td><td>BBB</td><td rowspan="2">A3</td><td>BBB</td><td rowspan="2">A3</td></tr>
<tr><td>Baa3</td><td>BBB-</td><td>BBB-</td><td>BBB-</td></tr>
<tr><td>Ba1</td><td rowspan="12">Not Prime</td><td>BB+</td><td rowspan="6">B</td><td>BB+</td><td rowspan="6">B</td><td>BB+</td><td rowspan="6">B</td><td rowspan="3">Non Investment Grade; Speculative</td></tr>
<tr><td>Ba2</td><td>BB</td><td>BB</td><td>BB</td></tr>
<tr><td>Ba3</td><td>BB-</td><td>BB-</td><td>BB-</td></tr>
<tr><td>B1</td><td>B+</td><td>B+</td><td>B+</td><td rowspan="3">Highly Speculative</td></tr>
<tr><td>B2</td><td>B</td><td>B</td><td>B</td></tr>
<tr><td>B3</td><td>B-</td><td>B-</td><td>B-</td></tr>
<tr><td>Caa</td><td>CCC+</td><td rowspan="3">C</td><td rowspan="3">CCC</td><td rowspan="3">C</td><td rowspan="3">CCC</td><td rowspan="3">C</td><td>Substantial Risks</td></tr>
<tr><td>Ca</td><td>CCC</td><td>Extremely speculative</td></tr>
<tr><td>C</td><td>CCC-</td><td>In Default, with little prospect of recovery</td></tr>
<tr><td>/</td><td rowspan="3">D</td><td rowspan="3">/</td><td>DDD</td><td rowspan="3">/</td><td>DDD</td><td rowspan="3">/</td><td rowspan="3">In Default</td></tr>
<tr><td>/</td><td>DD</td><td>DD</td></tr>
<tr><td>/</td><td>D</td><td>D</td></tr>
</table>

* International Agency; ** National Agency

[1] As at 2003 - CA-Ratings has since been taken over by Moody’s; a new national rating agency has also emerged: Global Credit Rating Co. The company is really the African arm of Duff and Phelps Credit Rating Co.

List A. BESA Listed Bond Issue Types

Issue Type	Acronym	Issue Type	Acronym
Amortising Floating Rate Notes	AFRN	Exchange Traded Fund	ETF
Amortising Instruments	AI	Floating Rate Note	FRN
Customised Instruments	CI	Weighted Floating Rate Note	FRNW
Credit Linked Note	CLN	Negotiable Certificate of Deposit	NCD
Commercial Paper	CP	Perpetuity	P
CPI-linked	CPI	Vanilla	V
Equity Structured Note	ESN		

Source: BESA (2007)

"Rating warning pushes Eskom to ask state for more cash"

(The Weekender, January 12th, 2008, p. 1)

"Fitch revises ratings for 37 companies"

(Business Report *, November 29th, 2007)

"Rating agencies are crunch scapegoats"

(Business Report *, August 18th, 2007)

"Moody's opens up options for Old Mutual"

(Business Report *, August 17th, 2007)

"Stocks trip with Sappi's rating"

(Business Report *, April 18th, 2007)

"Sentiment rises as S&P upgrades SA's credit rating"

(Business Report * August 2nd, 2005)

"Absa weathers Fitch downgrade"

(Business Report *, August 2nd, 2005)

"RMB asks for review to be withdrawn"

(Business Report *, July 4th, 2005)

"Fitch's downgrade delivers blow to Sappi's global image"

(Business Report *, April 21st, 2004)

"Nedcor falls on possible downgrade"

(Business Report *, January 29th, 2004)

"Credit rating agencies cough, and capital flees"

(Business Report *, October 28th, 2003)

* Published online by the Business Report – www.busrep.co.za

“Fitch downgrade adds to Sage gloom”

(Business Report *, January 6th, 2003)

“Five banks ask Fitch to withdraw ratings”

(Business Report *, May 13th, 2002)

“Good ratings provide boost for Mettle”

(Business Report *, May 10th, 2000)

* Published online by the Business Report – www.busrep.co.za

1 INTRODUCTION

1.1 Purpose of study

Liu et al (1999:337) assess the role rating agencies play as follows:

"Bond ratings agencies produce information about the default risk of debt issues and sell the information to investors. They also charge the bond issuers a fee for rating the debt qualities… These agencies provide investors with a system of relative creditworthiness of bond issues by incorporating all the ingredients of default risk into a single code."

Lately, international research on bond ratings have more and more focused on the informative value of credit ratings and the purpose credit rating agencies serve - even the extent to which ratings are timely and useful and the extent to which ratings can be predicted.

Given this background, the purpose of the research is to provide a general assessment of the impact credit ratings have on bond prices in South Africa: whether credit rating changes significantly impact bond prices or not.

1.2 Context of study

The South African Bond Market has experienced phenomenal growth over the last few years. Also, it is only recently that Standard and Poor's, one of the leading international credit rating agencies, has announced the opening of a local office in South Africa.[2]

Nevertheless, the general consensus is that bonds are still not a core - or preferred - method of finance in South Africa, Secondly, the market is still

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[2] This brings the count of credit rating agencies with local offices in South Africa to four, including one local credit rating agency. The agencies are: Fitch; Moody's (incorporating CA Ratings); Standard and Poor; and Global Credit Ratings Co.

relatively young and underdeveloped, compared to bond-markets in developed countries – notably that of the United States.[3]

Bonds have increasingly become an important investment tool in both developed and developing countries. Given the relatively short lifetime of the bond market in South Africa, little research work have been done on this particular market. In particular, to the knowledge of the author, no research has been done on the impact of credit rating changes on bond prices in the South African market, and little or no research on the general efficiency of the South African bond market.

It is not clear whether this corresponds with other markets, but local market sentiment towards rating agencies seems to be nothing more than neutral: refer to the newspaper articles included prior to Section 1: INTRODUCTION; a number of issuers have actually requested agencies to withdraw their ratings. Also, not all of the articles are full of praise.

With regards to international studies on the impact of credit ratings on bond prices, Cantor (2004) summarizes their findings perfectly: even when rating events do give rise to statistically significant contemporaneous price changes, the changes are often economically insignificant. As some of the more recent studies relating credit rating changes to bond prices, Bachelor and Manzoni (2006), Dallocchio et al (2006) and Steiner and Heinke (2001) post the following findings:

Steiner and Heinke (2001) observed significant bond price reactions for downgrade announcements and negative watchlistings while upgrades and positive watchlistings did not cause announcement effects. The authors also found a significantly stronger price reaction for downgrades into speculative grade.

Batchelor and Manzoni (2006) found that positive rating revisions were fully anticipated by the time the upgrade occurs. Negative revisions on the other

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[3] See for instance Ndlovu (2002) for an overview of the South African bond market.

hand were only partially anticipated, and spreads on downgraded bonds rose for some time after the downgrade had been announced.

The analysis of Dallocchio et al (2006) showed an absence of reaction for upgrades while downgrades did post some reaction. However, when the analysis was expanded to single issuers the authors found that downgrades had no relevant effect in most cases.

1.3 Problem statement

1.3.1 *Main problem*

The purpose of the research is to examine the impact of credit rating changes on bond prices in South Africa.

1.4 Significance of study

Firstly, the study is one of a few of quantitative nature on the bond market in South Africa. In particular, no prior research has been done regarding the impact of credit ratings on bond prices in South Africa. The research aims to support valuable work done by for instance, Ndlovu (2002), in developing the South African bond market.

Through a comprehensive literature review, the study consolidates the findings of some of the latest research in the field of credit ratings and bond pricing. In addition, it enhances knowledge by extending an existing methodology within a new (different) context. Again, to the knowledge of the author, studies relating bond prices to credit ratings in particular have predominantly been carried out within the USA, UK, Germany and France. Studies relating stock prices to credit ratings have mostly been confined to developed countries as well.

Also, the research and its findings promise to be valuable to both bond investors and the offices of rating agencies in that it provides some assessment of the efficiency or functioning of the South African bond market in general.

1.5 Delimitations and limitations

1.5.1 *Delimitations*

The study stretches over a limited period and incorporates certain c*orporate* - as opposed to government or municipal - bond issue types only, as delineated in subsequent chapters. Furthermore, the study solely focuses on the South African bond market with the exclusion of foreign-currency denominated South African bonds. Also, although prior-watchlisting as bond-attribute is considered and data regarding watchlistings is gathered, the study does not empirically investigate the relative price-impacts present in watchlistings themselves. Due to certain practicalities, only the ratings changes emanating from one rating agency (Fitch) were investigated.

1.5.2 *Limitations*

Methodologies available to probe the impact of credit rating agencies on bond markets are well developed – the extensive period over which research have been conducted in the field has facilitated many important developments in this regard. This lends to high expectations in terms of accuracy. Unfortunately, most of the methodologies generally require large sample sizes. In this particular case, the sample size that can be expected - given the relative age of the South African bond market - introduces some limitations in terms of the number of statistical tests that can be considered and carried out; in general, the sample size in itself poses to be a limitation to the research, its design and deductions.

Other limitations are volume traded and the nature of price data. The possible effects of these limitations on the study's results become clearer in the Methodology- and subsequent chapters.

1.6 Assumptions

The literature review builds on the premise that bond price determinants in developing countries are similar to the bond price determinants in developed countries. The assumption is outlined in more detail at the end of section 2.2 – Bond Price Determinants. Bond price determinants somewhat influence the literature review conclusions and thus the general hypothesis to be tested.

Another general assumption concerns differences in price data between the exchange market and dealer market, within South Africa – the study assumes no significant difference in this regard.

2 LITERATURE REVIEW

2.1 Introduction[4]

In his work, West (1973) asked three valuable questions related to bond ratings:

1. How are ratings determined?

2. Do ratings accurately discriminate among issues on the basis of default risk; for example, do default rates vary inversely with quality of ratings?

3. To what extent, if any, do ratings have an independent influence on bond yields; that is, do ratings - as opposed to the underlying economic factors that influence ratings - have an impact on the market prices of bonds?

It is well known that bond ratings and bond prices are highly correlated (see for instance Liu et al 1999:338). Therefore, a reaction in bond prices in response to a rating change may be ascribed to the possible independent impact that bond ratings and bond rating changes have on bond prices (directly ascribable to the rating), as well as to the mutual determinants both ratings and bond prices share (only indirectly ascribable to the rating).[5]

Consequently, it is believed that literature relevant to a study of *the (independent) effect of credit ratings* on *bond prices within South Africa* are captured in articles investigating bond rating quality as well as literature on bond price determinants. Again, as a number of previous research did, the question is asked whether bond credit ratings and bond credit rating changes contain private information. Elaborating on the link between bond rating

[4] No general background on ratings and rating agencies are offered in the literature review; interested readers can reference the excellent work of Sylla (2001).

[5] This argument is in fact the basis of an eminent critique of studies relating bond prices to bond rating changes – see for instance Liu et al (1999:339) and Kliger and Sarig (2000:2880).

quality and bond prices: bond rating quality assists in describing credit ratings – what does a credit rating really mean, entail or imply? (The question is essentially still being answered to this day.)

Perry et al (1988) note that corporate bond ratings have been the focus of research for many years. A background study on research that has focused on the issue of credit rating quality quickly reveals that it is an established topic that has received considerable attention to date. Over the years, many researchers have addressed bond ratings and bond rating quality from different angles and with various different methodologies. In a review of recent research on credit ratings, Cantor (2004) notes six branches that the growing body of research on credit ratings generally take:

1. Understanding rating transitions
2. Rating determinants and stability
3. Understanding the role of credit ratings as tools for portfolio governance
4. Relating bond prices and spreads to credit ratings
5. Relating changes in market prices to changes in credit ratings
6. Relating sovereign risk and sovereign ratings

This particular study and its objective is first of all delineated and contextualized by the six branches listed above; this study essentially belongs to the third branch, *"Relating changes in market prices to changes in credit ratings"*. A general critique of past events studies relating bond prices to rating changes is that their results are conflicting; the outcomes are mixed and inconclusive (Reiter and Ziebart 1991). Nevertheless, these studies raise the important question whether a significant impact on bond prices is registered – or put differently, how bond prices develop - around the announcement date of a rating change, and from an "inquisition-into-market-efficiency" perspective, or from a market-functioning perspective, this question has meaning.

Cantor (2004) summarizes the findings of studies relating market changes to rating changes as:

a) In the months prior to rating events, bond and equity prices decline or rise sharply in ‘‘anticipation’’. These patterns do not necessarily imply that investors are focused on ratings, per se, or attempt to forecast rating changes. Rather, investors may simply be concerned about the same factors that determine ratings;

b) Market price changes, prior to rating events, are generally larger than theoretically implied by the subsequent rating event itself (although studies do not generally draw attention to this finding);

c) Negative rating events (announcements of downgrades and reviews for possible downgrade) generally give rise to statistically significant contemporaneous price or spread movements;

d) Positive rating events give rise to smaller, less significant, contemporaneous price or spread movements;

e) Though not emphasized in the literature, even when rating events do give rise to statistically significant contemporaneous price changes, the changes are often economically insignificant – much smaller than would be suggested by the magnitude of the rating change itself.

Cantor’s explanation of “anticipation” is clearly related to the former discussion on the strong correlation between bond ratings and bond prices; a movement in the latter cannot directly or instantaneously be attributed to the independent impact of the rating change on the bond price.

The excerpt suggests several important instances to consider when investigating the impact of ratings on bond prices: a) the occurrence of significant impacts around a rating announcement; b) the economical importance of any significant impacts; c) the relative development of prices around a rating change[6]; d) the possibility that impacts may differ for events due to different issue-attributes[7]; e) the possibility of a difference between the actual price development and an expected price change.[8]

Cantor (2004) mentions that past event studies relating bond prices to rating changes have generally not paid particular attention to the price change implied by the rating change. For now, it is purported that *the expected price change in the wake of a rating announcement ought to depend on the change in yield-premium implied by the rating announcement*; this is nothing new really – comparable bonds generally yield comparable premiums and although simplistic, a rating change can be seen as a transition from one cluster of comparable bonds to another. Furthermore, *the change in yield-premium ought to be directed by bond price determinants*; it should be possible to explain the (expected) change in yield premium by referring to bond price determinants. Consider the implication of the first statement: a finite yield-premium change presupposes a theoretical limit on the impact the rating announcement can have on the bond price – it effectively (theoretically) suppresses it; the price impact ought to be proportional to the implied change in yield-premium. This is also consistent with the work of Jorion and Zhang (2007).

Also remarkable about past studies, and as Cantor (2004) equally points out, these studies generally post that events are anticipated in advance. This statement is normally based on Cumulative Abnormal Returns (CAR) results and aided by Cumulative Abnormal Returns graphs. What is interesting about Cumulative Abnormal Returns graphs is the implied "*market adjustment" rate* - the time the market takes to fully absorb and adjust to a rating announcement - of bonds affected by rating events. Regardless of whether the rating announcement contained information or not, under certain circumstances one might expect the affected bond's price to have fully developed or adjusted

[6] In particular, refer to points a) and b) of the summary excerpt from Cantor (2004).
[7] Although very trivial as an example, compare points c) and d) of the summary excerpt from Cantor (2004).
[8] Refer to point b) of the summary excerpt from Cantor (2004).

soon after the rating change is formalized (announced) – if not to the pre-rating returns, at least to the post-rating returns.

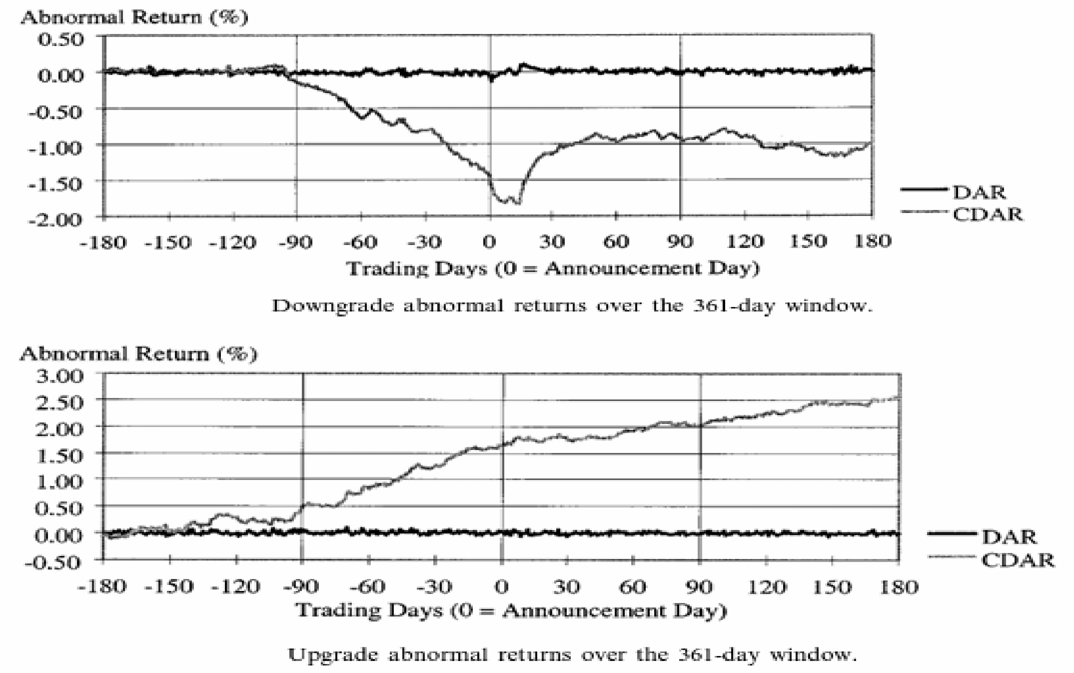


Figure 1. CAR – Steiner and Heinke (2001)

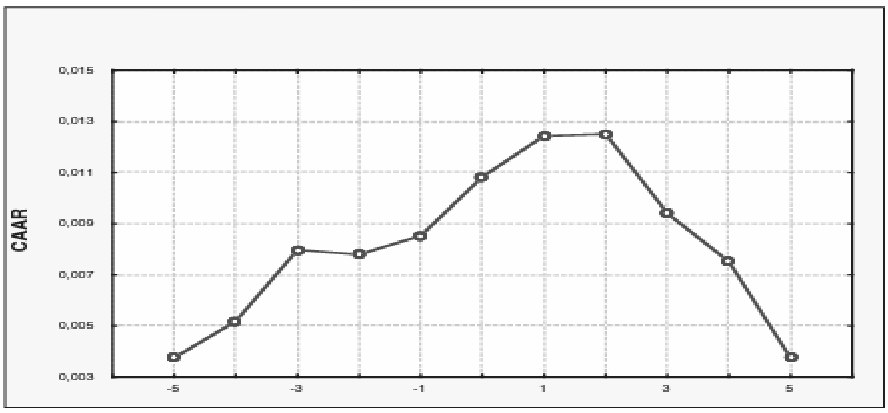
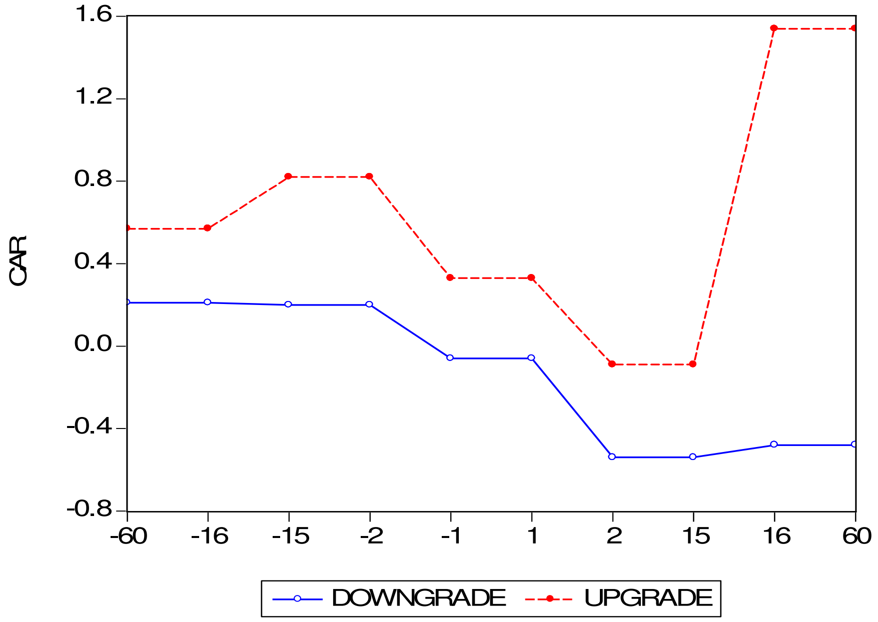


Figure 2. CAR – Dallocchio et al (2006)

Figure 1 shows the CAR graphs posted by Steiner and Heinke (2001); Figure 2 shows that of Dallocchio et al (2006). The CAR graphs of Figure 3 were constructed from the CAR results posted by Bachelor and Manzoni (2006).



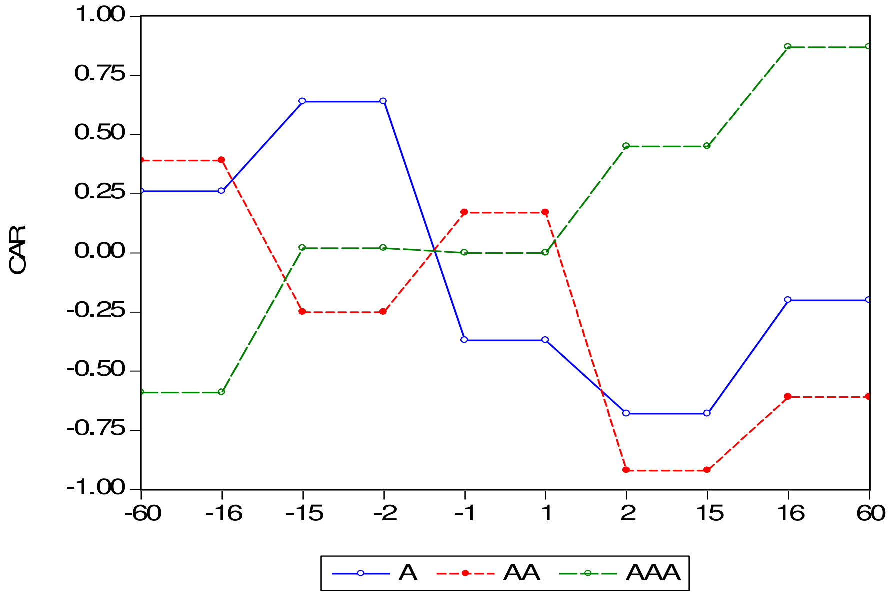


Figure 3. CAR – Bachelor and Manzoni (2006)[9]

The three mentioned studies from which the CAR graphs were taken each differ in terms of the methodology used to isolate abnormal performance. Steiner and Heinke (2001) referenced affected bonds against government

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[9] The figures are based on CAR values posted in table format by Bachelor and Manzoni (2006)

(risk-free) bonds; Bachelor and Manzoni (2006) utilized “identical” individual corporate bonds to closely match affected bonds; and Dallocchio et al (2006), for the purpose of calculating CAR, forecast expected returns by adopting a method similar to that employed by Gropp and Richards (2001).[10]

In addition, most studies mainly consider pre-announcement ratings when isolating abnormal performance. Hypothetically, should this be alternated to post-announcement ratings, should one expect the CAR graphs to be reversed to some extent, i.e. a convergence of abnormal returns instead of a divergence?[11]

The methodology of some of the previous studies entails the utility of a (composite) bond index to isolate abnormal performance - Refer to Table 27 under APPENDIX A. In cases where the index is not constructed based on (similar) rating, any alteration - basing calculations on pre-announcement ratings versus post-announcement ratings - will essentially result in the same reference being employed for both alterations. This particular outcome ought to be insightful: refer to the daily holding period returns equations, Equation [29] and Equation [30] under the Research Methodology chapter – should it be expected that abnormal returns:

…will fully disappear (converge) after some time, based on the methodology’s underlying assumption that (daily holding period) returns of the reference and observation are equal - the price of the affected issue perfectly adjusts such that holding period returns again becomes equal; potential arbitrage opportunities are thus eliminated; or

…will not fully converge due to a re-valuation of the observation’s future cash flows past the next expected coupon - the re-valuation of future cash flows causes the price and thus (daily holding period) returns of the observation to remain different to that of the reference; arbitrage opportunities are rather suppressed by the value (price) of the bond?

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[10] The method employed by Gropp and Richards (2001) is essentially a market and risk adjusted based model; the model is examined under the Methodology chapter.
[11] Refer specifically to the CAR graphs posted by Steiner and Heinke (2001).

The case really depends on the relative similarity between the reference and the observation, and highlights the potential sensitivity of results to the methodology used to isolate abnormal performance. This places emphasis on the determinants of bond prices. In addition to informing the price change to be expected, bond price determinants also directs the isolation of abnormal performance.

The specific period at which point a significant impact is found can imply many things, as can the development of prices over time. For instance, should it occur after the announcement date, it could mean that the rating genuinely contained price sensitive information new to investors (see for instance Livingston et al 2003), or, that investors depend on ("outsource to") rating agencies and therefore possibly (overly) rely on ratings (see for instance Chan and Jegadeesh 2004).

Should a significant impact occur before the announcement date, it could mean that investors "anticipated" the event; they either anticipated (expected) a rating announcement or priced similar factors that eventually led to the rating announcement (Cantor 2004).[12] The latter argument is not that unthinkable: various authors question the timeliness of ratings and thus rating changes, and/ or argue that investors and rating agencies essentially have different perspectives (see for instance Chan and Jegadeesh 2004; Altman and Rijken 2006 and even Löffler 2003). Furthermore, rating agencies typically watch-list an issuer in advance of rating changes, and the fundamental financial information that can trigger a rating action is usually available to market participants well before the downgrade (Dynkin et al 2002:91). How much of a significant impact and price development is measured is also important.

Section 2.2 reviews literature on the price determinants of bonds. The determinants of bond prices may shed light on the possibility of a price

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[12] Again the strong correlation between bond ratings and bond prices comes into play – under the context of *a strong correlation between ratings and bond prices*, "expecting a rating announcement" and "pricing similar factors" might essentially mean the same thing.

development prior to rating announcements. Secondly, studying bond price determinants also ought to clarify to what capacity credit ratings can be an independent bond price determinant, if at all. Lastly, an inquiry into bond price determinants simultaneously assists in the selection of an appropriate methodology to be utilized by the study in investigating the market.

The finding of a significant bond-price impact due to a rating announcement on or after the announcement date is also determined by the independent impact credit ratings may have on bond prices. Therefore, the question is asked: given that bond ratings and bond prices are correlated, what independent impact could bond ratings possibly have on bond prices? Also of importance, should credit ratings contain private information (as opposed to publicly available information), then how, when, and under what circumstances will investors price it? Section 2.3 examines the independent impact of credit ratings on bond prices.

Past bond-price event studies do in fact cite various factors – mostly bond-specific attributes - that can affect the price-reaction of bonds to rating announcements. According to these articles, certain bonds react or might react differently to rating announcements, due to (differences in) particular bond-attributes. The attributes are: a) bonds that undergo a major rating change (as opposed to only a slight rating change, mostly within the particular rating grade); b) bonds that had been watch-listed prior to the announcement; c) bonds belonging to firms in financial crisis; d) bonds from different issuer types (sub-category) and nationalities; and even e) bonds that are rated by different rating agencies. The most basic factor is of course the implied direction of the rating announcement - the reaction of bonds that are upgraded differs from that of bonds that are downgraded. In its review, Section 2.4 focuses more on issue-specific factors or attributes that affect the reaction of bonds to rating announcements, as cited by prior research.

2.2 Determinants of Bond Prices

Not all bonds are priced alike. In the interest of brevity, the discussion in this section predominantly focuses on certain corporate bonds - mostly “common” or “ordinary” corporate bonds. Bonds that do not receive special attention in this section are listed below. These bonds are seen to deviate from the method of pricing ordinary corporate bonds, irrespective whether the deviation implies more simplicity or complexity. Furthermore, the pricing of these bonds might be influenced by additional factors than the factors mentioned in this section, or might require the omission of some of the factors mentioned in this section. Needless to say, their exclusion considerably simplifies the section, in that fewer cross-comparisons are necessary between the risk- or price-factors introduced in the section and their relative impact on different bond types.

Although this is of course outside the scope of this study, it is believed that it would always be possible to re-examine the pricing of these omitted bonds at a later stage, through a relative comparison of the omitted bonds with the bonds considered in this section, as well as the discussion in this section.

a) Bonds issued by issuers other than local corporates: bonds issued by local governments, local municipalities and local-denominated bonds issued by foreign corporates (including government flower bonds and index-linked bonds)

b) Foreign-denominated bonds issued by local corporates and other issuers

c) Bonds with odd principals and coupon rates: bonds with odd coupon dates, deferred coupon bonds and floating rate bonds, as well as bonds with sinking funds

d) Amortizing securities: asset backed securities and mortgage backed securities

e) Bonds with embedded options: call features, put position, convertible bonds, exchangeable bonds

Moving on, Fabozzi (2000) gives three reasons for the change in the price of a bond:

a) There is a change in the required yield due to changes in the credit quality of the issuer

b) There is a change in the required yield due to a change in the yield on comparable bonds

c) There is a change in the price of the bond selling at a premium or at a discount, without any change in the required yield, simply because the bond is moving toward maturity

Given the nature of bonds, as yields in the marketplace change, the only variable that can change to compensate an investor for the newly required yield in the market is the price of the bond (Fabozzi 2000:23). The relationship between the price of the bond and its yield is non-linear (a convex plot). As is known, *Bond Price Volatility* furthermore refers to the degree of change in the price of a bond, given a certain change in its yield.

Having now roughly reintroduced the relationship between bond prices and the required yield, the three reasons for a change in the price of a bond, according to Fabozzi, can thus be summarized as either due to the bond's particular maturity at the time, or due to changes in the required yield in the market. The latter is examined next.

It is common practice to express the yield on a risky corporate bond as the yield premium over the yield on a comparable riskless government Treasury bond:

Base Interest Rate + Spread

…or

Base Interest Rate + Risk Premium (Fabozzi 2000:90)

The Base Interest Rate is the yield to maturity offered on a comparable maturity Treasury security that was most recently issued, and gives the bare minimum yield an investor would seek (Fabozzi 2000:89). Therefore, knowledge about the factors influencing the base interest rate, but more importantly, the factors that influence the risk premium will mostly explain the yield on a bond and therefore its price. The latter is reviewed in the next step.

Fabozzi (2000) notes several factors that affect the yield spread: a) the type of issuer; b) creditworthiness of the issuer; c) inclusion of options; d) taxability of interest; e) expected liquidity of an issue; f) term to maturity. Although noted above, point c) – namely *inclusion of options* - will not receive attention here, given that bonds with embedded options have mostly been excluded from discussion in this section. All of this is trivially put together in Equation [1] as the required yield spread for corporate issue i.

$$Yield\,Spread_i^{corp} = \int \{Maturity, Taxability, Liquidity, Creditworthiness, Issuer\,Subcategory\} \qquad \textbf{[1]}$$

Liquidity

Investors require a liquidity premium as not all bonds are liquid. Fisher (1959) sees the impact of bond liquidity on the bond's price as (the risk associated with) the difficulty of turning the bond into cash before it matures.[13] Foss (1995) defines liquidity risk simply as the ability to sell into a bear market: a liquid market is characterized by the ability to sell an asset in a timely and cost-effective manner. The quintessential liquid market exhibits narrow-bid-ask spreads in all market environments. Houweling et al (2005) and Elton et al

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[13] Another useful view on liquidity by Fisher (1959) is *market imperfection* – the effect of the actions of a single individual on the price of a security. "If securities markets were "perfect" (in the sense that the actions of a single individual could have only an infinitesimal effect on the price of a security), it would not be necessary to take up this topic at all; turning a bond into cash would be no problem. It is true that an investor who disposes of any interest-bearing security before maturity may have to take a loss because of changes in the pure interest rate between the time he buys his bond and the time he sells it. But such losses are allowed for by defining risk premium as the difference between the yield on the bond under consideration and the yield on a bond of the same maturity which is sure to be paid, so that compensation for possible changes in the pure rate of interest is present even in the yields on riskless bonds. Thus marketability can influence the risk premium only if it measures the degree of imperfection - the effect of a single individual's action on price - in the market for a particular security…Imperfection of the market for bonds can be expected to result in bondholders' demanding compensation for risk because it makes the price and yield of a bond at any particular moment uncertain." (Fisher 1959:224)

(2004) provide some indication of the impact liquidity can have on the price of a bond.

Taxability

Taxability refers to differences in the tax treatment of government, municipal and corporate bonds. In short, the after-tax return on corporate bonds should compensate investors for taking on incremental risk over less risky government- and Treasury bonds. The before-tax return should compensate investors for incremental risk plus any disadvantages due to tax-differentials: assuming for a moment that corporate bonds were not riskier than - but rather as risky as - government and Treasury bonds, any investor investing in corporate bonds, instead of government or Treasury bonds, would be disadvantaged if the different bonds were similarly priced (due to comparable risk), but taxed differently (unfavourably), and the investor were not somehow reimbursed for this. Both Athanassakos and Carayannopoulos (2001) and Elton et al (2001) are examples of recent studies of bond price determinants that incorporate taxability.

Maturity

The effect of maturity or term to maturity on bond premiums can be roughly outlined by noting the three (short term; intermediate term; long-term) maturity sectors[14] and *maturity spread* – the spread between any two maturity sectors; also by noting *term structure of interest rates* - the relationship between yields on otherwise comparable securities with different maturities. Bond price volatility is also dependent on maturity.

Creditworthiness

Creditworthiness, as described by Fabozzi (2000) refers to credit risk or default risk – the risk that the issuer of a bond may be unable to make timely principal and/or interest payments. Therefore, it is appropriate for the author

[14] Fabozzi (2000) defines short term as bonds with a term to maturity between one and five years; intermediate term as bonds with a term to maturity between five and twelve years; and long term as bonds with a term to maturity greater than twelve years.

(Fabozzi) to also draw the issue's credit rating into the discussion of creditworthiness. Figure 4[15] indicates that credit risk, when seen as default risk[16], is in fact not *the* major determinant of yield premiums - or Equation [1] for that matter.[17] At this point, creditworthiness in Equation [1] is then rather presented as credit risk in Equation [2].

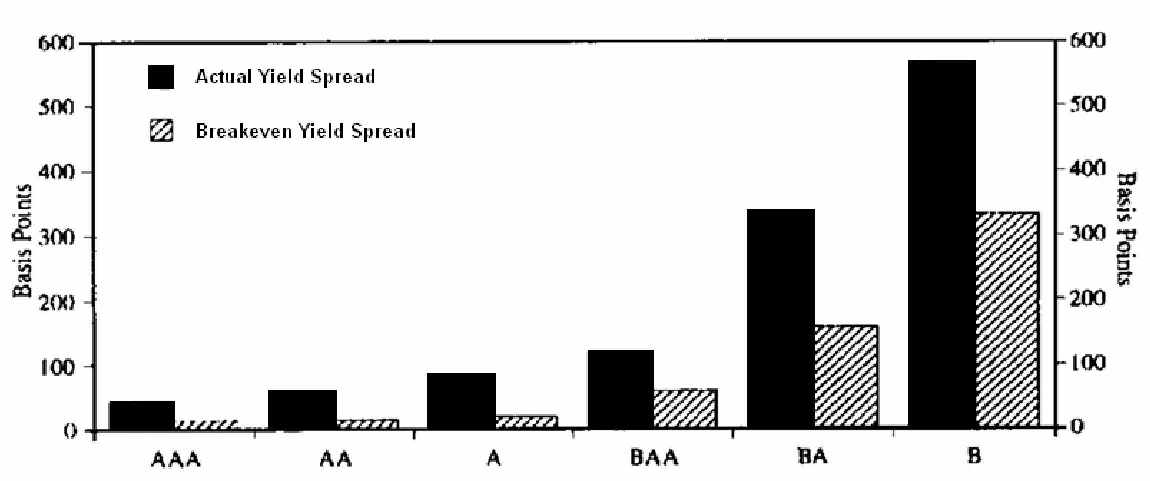

Figure 4. Actual versus Breakeven Yield Spread over Treasury: Ten Years 1983-1992

Source: Bennett et al (1994)

Issuer Subcategory

In discussing *type of issuer (*point a), Fabozzi (2000) refers to market sectors - governments and their agencies; municipalities; corporates; foreign issuers - and also sub-categories of market sectors. In particular, the corporate market

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[15] With regards to Figure 4, the calculation of additional yields required to offset default losses was based on incremental and cumulative default rates per rating category over the ten year period: 1983-1992. The calculation assumes that an investor bought an equal-weighted portfolio of ten-year corporate bonds. The incremental defaults are broken down into semi-annual losses on principal using a 40% recovery rate. Treasury benchmark yields of December 1992 were used to solve the increment of average additional coupon required on the corporate portfolio to offset the default losses and to produce a return identical to the Treasury benchmark yield. The analysis was relative insensitive to Treasury benchmark rates chosen. Actual yield spreads offered were derived from yield statistics on new issues (see Bennett et al 1994).

[16] What Credit Risk exactly implies appears to be still somewhat vague and the term ill-defined. In most cases, the common assessment would be that it represents default risk - as one of many examples, see for instance the description of creditworthiness by Fabozzi 2000:93; credit risk and default risk is seen to be the one and the same thing. Based on the separate and different definitions of credit risk and default risk offered by Foss (1995), it can be questioned whether credit risk simply equates directly to default risk in all cases. The definitions of Foss (1995) are reviewed later-on in this section.

[17] Further support for the fractional impact of default risk on bond yields can be found in Athanassakos and Carayannopoulos (2001); Elton et al (2001); Huang and Huang (2003); Delianedis and Geske (2001).

sector can be sub-divided as follows: industrial companies; utilities; finance companies; and banks. This then allows the phrases *inter-market sector spread* and *intra-market sector spread* – the differences between the spreads in two sectors of the bond market and differences between the spreads of two issues within a market sector, respectively.

Athanassakos and Carayannopoulos (2001) explored the relationship between bond yield spreads (risk premiums) for various industries and the business cycle/ economic environment, while at the same time controlling for default risk, tax implications and issue traits (such as liquidity, callability and the existence of a sinking fund). Athanassakos and Carayannopoulos (2001) found that the impact of the business cycle (macro-economy) on the yield spread of a corporate bond depends on the industry sector to which the issuer of the bond belongs. For example: for the industrial sector, bond yield spreads are generally higher during recessionary periods (periods of lower industrial production), whilst the opposite is true for utilities.[18] [19]

$$Yield\,Spread_i^{corp} = \int \{Maturity, Taxability, Liquidity, CreditRisk, Issuer\,Subcategory\} \qquad \textbf{[2]}$$

Supply and Demand imbalances, the Business Cycle and Systematic Risk

Equation [2] can be further developed by also incorporating the research of Athanassakos and Carayannopoulos (2001), and certainly as important, the work of Elton et al (2001).

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[18] Still, intra-market sector spread is not the major contributor to bond yield spreads – this is reaffirmed when Elton et al (2001), Elton et al (2004), and Athanassakos and Carayannopoulos (2001) are cross-examined and the respective models' success-rates are compared. Also note that in their study, Athanassakos and Carayannopoulos (2001) especially and specifically accounted for the business cycle when selecting the period of their study.

[19] The question can also be raised whether an issue's credit rating – as an indication of credit risk - does not simultaneously take its sector sub-category (industrial; utility; financial; bank) into consideration for the particular period at hand, thereby eliminating the need to separate "*Issue Sub-category*" and "*Credit Risk*" in Equation [2]; Can *Issue Sub-category* be omitted from Equation [2] as it is already accounted for by *Credit Risk*? On this point: it is the intent of rating agencies to rate "through-the-cycle"; Amato and Furfine (2004) conclude that credit ratings - or rather the rating process - do not generally exhibit excess sensitivity to the business cycle. They summarize that pro-cyclicality is only detected in ratings when investment grade firms or newly assigned ratings and rating changes are examined; and that the results for some specifications suggest that ratings might even exhibit excess sensitivity to the business cycle. Altman and Rijken (2006) conclude that rating outlooks reflect only a more moderate version of a through-the-cycle perspective. Thus, rating reviews are doubted to be pro-cyclical.

Important about the work of Athanassakos and Carayannopoulos (2001) is that it moves away from the assumption that capital markets are frictionless (taxes impose a severe wedge between before- and after-tax returns) and that information is costless (while in the long-run markets reach an equilibrium level, in the short run deviations from equilibrium exist due to costly information, the existence of transactions costs and liquidity considerations which are imposed either by the business cycle or by circumstances specific to the issue) when modelling the effect of default risk on bond yields.

Not surprisingly, in their study Athanassakos and Carayannopoulos (2001) proxied for default risk with a) the issue's rating; b) the issue's maturity; c) the inclusion (existence) of a sinking fund. The issue's rating captures both likelihood of default as well as an indication of the recovery rate. The reason for including maturity as proxy for default risk is that default risk, and thus the yield spread of a corporate bond, is also assumed to be a function of the bond's maturity.[20] Similarly, the calculation of default risk in Elton et al (2001) depends on default probabilities and recovery rates, and also coupon rates.[21] In addition, Bennett et al (1994) also quantifies default risk by calculating resulting default losses.[22] Credit risk in Equation [2] can therefore - quite elementary - be replaced with *Default Probability*; *Recovery Rate* and *Maturity*.[23]

Apart from the relationship between issuer-type and the business-cycle, Athanassakos and Carayannopoulos (2001) also show that yield spreads depend on the business-cycle in general and that the relative supply (and demand) of corporate bonds to government bonds do matter.[24] Athanassakos and Carayannopoulos (2001) forms an important complement to the work of

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[20] The authors cited Litterman and Iben (1991) and Fons (1994) on this point.
[21] In Elton et al (2001), default risk was modelled theoretically though. The modelling of default risk was based on a reduced form model incorporating bond ratings, a sub-class of reduced-form models. Reduced-form models are an alternative to structural models in the pricing of risky securities - see Elton et al (2003). This explains the incorporation of coupon rates.
[22] As is discussed later-on, Foss (1995:29) defines default risk as the risk that the issuer of a fixed-income security will be unable to make timely payments of interest or principal. This risk, diversified over a portfolio of equally rated securities, leads to an expected default loss.
[23] This of course assumes that credit risk only consists out of default risk, a point raised before and revisited later-on.
[24] The authors cited the findings of Dialynas (1998); yield spreads vary as quantities available at different risk-classes change.

Elton et al (2001) in that the authors argue that economic conditions are expected to affect the size of the yield spread investors demand.[25] *Temporary Supply and Demand Imbalances* is added to Equation [2] as bond price determinant; also, *Issuer-subcategory* is indicated to be influenced by the business cycle.

Similar to Athanassakos and Carayannopoulos (2001), Elton et al (2001) also incorporated default risk and taxes in explaining corporate yield spreads In contrast with Athanassakos and Carayannopoulos (2001), Elton et al (2001) defined yield spreads as the difference between the spot rates (yield-to-maturity on zero-coupon bonds) on a corporate bond and a Treasury bond of similar maturity, and they tested whether yield spreads move systematically with other assets in the market by studying the sensitivity of yield spreads to risk factors that have been used as systematic risk factors in the pricing of common stocks.

The systematic risk factors selected were the three Fama-French (1993) factors: the excess return on the market (the RM-RF factor); the return on a portfolio of small stocks minus the return on a portfolio of large stocks (the SMB factor); and the return on a portfolio of high minus low book-to-market stocks (the HML factor). Elton et al (2001) found that systematic risk is indeed present in bond yield spreads, and that the sensitivity to all of the factors tends to increase as maturity increases and to increase as bond quality (rating) decreases - also see Figure 5. Furthermore, 85% of the industrial unexplained spread is accounted for by the three risk sensitivities and for financials it is 67%.

“We have shown that sensitivity to the factors that are used to explain risk premiums in common stocks explains between 2/3 and 85 percent of the spread in corporate and government rates that is not explained by the

[25] Unfortunate for this study, the effect of the business cycle poorly attributes to a specific (risk and thus yield) determinant; the business-cycle itself may proxy for and explain yield spread volatility and risk in general, it seems to be more of a secondary factor rather than a primary factor.

difference between promised and expected payments and taxes." (Elton et al 2001:272)

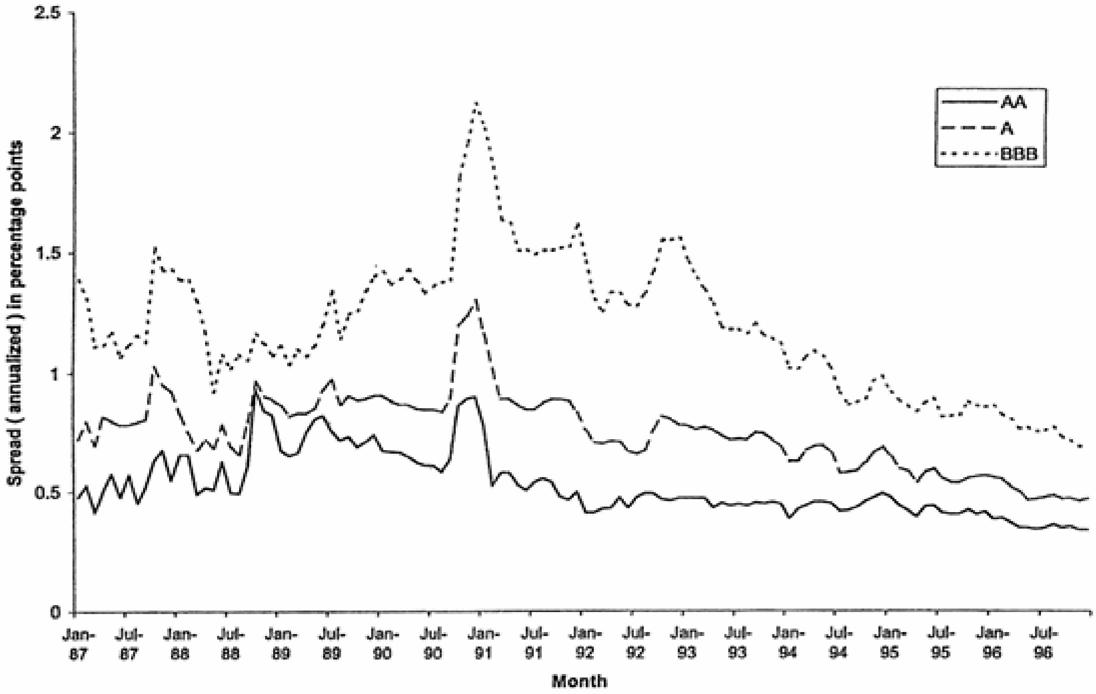

Figure 5. Empirical spreads on industrial bonds of six years maturity

Source: Elton et al (2001)

In conclusion, Elton et al (2001) found that differential taxes are a more important influence on spreads. Taxes account for a significantly larger portion of the differential between corporate and treasuries than do expected losses. For 10-year A-rated bonds, taxes accounted for 36.1% of the difference compared to the 17.8% accounted for by expected loss. In addition, in the case of 10-year corporates, 46.17% of the difference is unexplained by taxes or expected default. The vast majority of this difference is compensation for systematic risk and is affected by the same influences that affect systematic risks in the stock market. Making use of the Fama-French factors, as much as 85% of that part of the spread that is not accounted for by taxes and expected default can be explained as a reward for bearing systematic risk. Systematic risk is thus added to Equation [2].

At this point, Equation [2] is rewritten as follow[26]:

$$
\textit{Yield Spread}_i^{corp} = \int \begin{Bmatrix} \textit{Maturity}, \textit{Taxability}, \textit{Liquidity}, \\ \textit{Issuer Subcategory}(\textit{Business Cycle}), \\ \textit{Default Risk}(\textit{Rating}(\textit{Default Probability}, \textit{Recovery Rate}), \textit{Maturity}), \\ \textit{Temporary Demand and Supply Imbalances}, \\ \textit{Systematic Risk}(\textit{Issuer Subcategory}, \textit{Rating}, \textit{Maturity}) \end{Bmatrix} \qquad \textbf{[3]}
$$

What is emerging from Equation [3] at this stage is that a number of the purported bond price determinants are actually interlinked. For instance, *Maturity* is seen as an independent factor, but it also impacts on *Default Risk* and *Systematic Risk*. Similarly, it may very well be that *Issuer Subcategory* is captured by *Default Risk*. Also note how many times and where *Rating* pops up. Also compare *Systematic Risk* and *Issuer Subcategory.*

Nevertheless, based on the findings of Elton et al (2001), and others, taxes (more than 30%) and systematic risk (more than 30%) seem to have the greatest impact on the yield premiums. next in line must be *Default Risk*. To what extent can Equation [3] be used to explain Figure 6?

It must still be asked why bond prices are influenced by the systematic risk of common stocks. Why do investors price this systematic risk, given the nature of bonds and the (risk) context being the bond-market? Referring back to Athanassakos and Carayannopoulos (2001), this particular question is similar to the question why the business cycle affects bond prices. There has to be a risk involved for bond premiums to move with common stocks, but is it “systematic risk” per se? Can it be that another risk-factor(s) is involved, that is just highly correlated with or accounted for by the systematic risk factors?

Elton et al (2001) offer two possibilities why systematic risk influences yield spreads. First, if expected default loss were to move with equity prices (so

[26] Houweling et al (2005) [more extensive proxies for measuring liquidity]; and Peter and Grandes (2005) [the concept of indirect sovereign risk, especially in developing countries] also offer further extensions, but fall outside the scope and purpose of this section.

while stock prices rise default risk goes down and as stock prices fall default risk goes up), it would introduce a systematic factor. Second, the compensation for risk required in capital markets changes over time. If changes in the required compensation for risk affect both corporate bond and stock markets, then this would introduce a systematic influence.

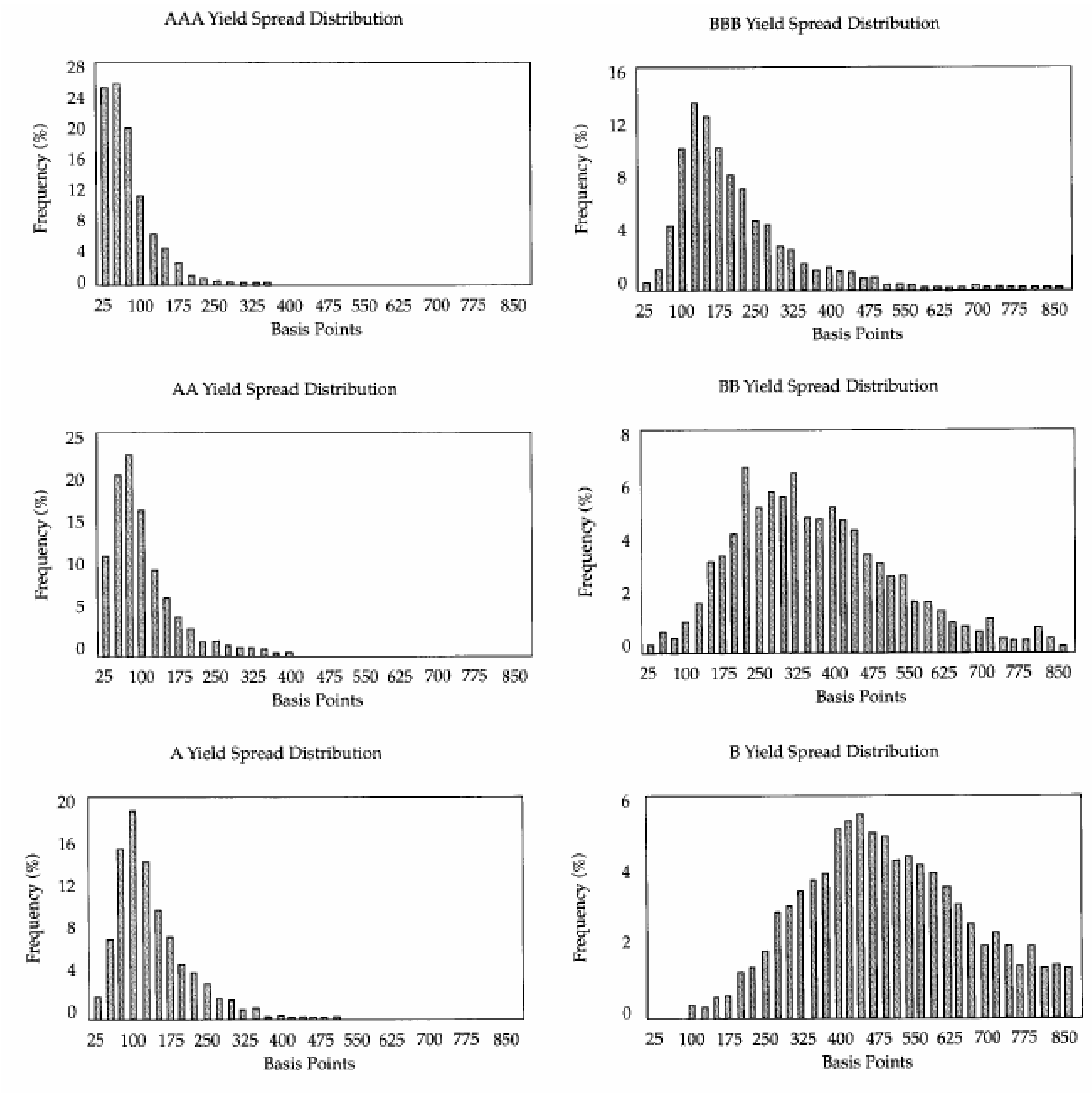

Figure 6. Historical Yield Spread Distributions for six Credit Rating Categories

Source: Foss (1995)

Downgrade Risk

Foss (1995) notes that the terms: *Default Risk* and *Credit Risk* are often used interchangeably. The incremental yield spread on a corporate bond compensates investors for the incremental risks of holding default-prone debt rather than risk-free Treasury bonds; excluding all embedded options, the constituents of the yield spread on any corporate bond - according to Foss (1995) - are:

a) the expected default loss on a diversified portfolio of equally risky bonds;

b) a credit risk premium required to compensate risk-adverse investors;

c) a liquidity risk premium required to compensate risk-adverse investors

Foss (1995) defines D*efault Risk* as the risk that the issuer of a fixed-income security will be unable to make timely payments of interest or principal. This risk, diversified over a portfolio of equally rated securities, leads to an expected default loss. *Credit Risk* is defined as the risk that the perceived credit quality of an issuer will change, although default is not necessarily a certain event.

The work of Dynkin et al (2002) supports the view on credit risk of Foss (1995), although they more often refer to it as downgrade risk. In a nutshell, the work of Dynkin et al (2001) is mostly about the establishment of a quantitative framework to address the issues of credit risk and diversification and to minimize exposure to downgrade risk. In discussions from this point forward, the terms credit risk, default risk and downgrade risk are seen as follow:

a) Credit risk as defined by Foss (1995) is essentially identical to downgrade risk as seen by Dynkin et al (2002) – for both the term *downgrade risk* is rather used;

b) Creditworthiness – or even Credit Risk - is then taken to capture and include default risk together with downgrade risk. Thus, Credit Risk is taken to mean the same as Default Risk, as long as Default Risk also incorporates Downgrade Risk. Downgrade Risk is also seen as synonymous to Variation in Default Risk.

Dynkin et al (2002) note that disappointing earnings, a large equity buy-back, a planned change in financial leverage, a merger announcement or a rating action are all examples of developments that increase the market's perception of the probability of downgrade (or default) in the investment-grade market. Also, defaults directly from investment-grade are rare, but any degradation in an issuer's creditworthiness almost inevitably results in its market underperformance, and then its eventual downgrade.

By calculating the consequences on the returns-performance of downgrades, Dynkin et al (2002) were able to model downgrade risk in a single bond and later-on for portfolios. Two approaches were followed to quantify the performance effect of a downgrade; and both involved the use of rating transition probability matrices. First, the investment grade market was partitioned by quality (three levels: AAA-AA; A; BBB), sector (industrial, financial, utilities, non-US issuers) and duration (under four years, four to seven years, over seven years) – thereby forming thirty-six peer groups. Next, excess returns over duration equivalent Treasuries were calculated for each security and a bond's out-performance relative to its peer group (the average return of the peer group) was determined.[27] The expected loss due to a downgrade is given by the probability of a (downgrade) rating transition multiplied by the mean return underperformance due to a downgrade. The other alternative is to base the calculation on transition probability matrices and the difference between the average spread levels for the two particular quality ratings (pre-downgrade and post-downgrade).

[27] In this approach, the authors found that peak downgrade losses occur at different times for different credit qualities. The authors commented that this finding supports the conventional wisdom that the main source of credit risk in higher qualities is related to specific credit events, while in the lower qualities it is driven by recessions.

Dynkin et al (2002) note that the results can be viewed as a measure of the extent to which the credit spread compensates investors for the risk of downgrades.

“The average Baa spread over Treasuries of 234 bp might be interpreted as the expected excess return of Baa credits over Treasuries under a no-change scenario. Even absent any systematic change in the credit spreads, the effect of rating transitions carries an expected under-performance of 58 bp. Subtracting this expected loss from the spread of 234 bp, we see that the expected excess return of a Baa bond over Treasuries is only 176 bp.” (Dynkin et al 2002:95)

Downgrade risk - and reasons why downgrade risk must be compensated - can be better understood by investigating two possible perspectives on the matter.[28] The first is evident from the following paragraph taken from Dynkin et al (2002:95):

“For example, we expect a bond suffering a downgrade from A to Baa over the course of the coming year to see its spread widen by about 76 basis points (234 - 158) over that time. If it has a five-year spread duration (which is about the average for the Lehman Brothers Credit Index), this will result in a return of -3.77%.”

The first perspective argues that if an issue is downgraded, the investor over-paid for the particular bond that was downgraded; the perspective considers that default losses (insinuated by default risk) are higher for downgraded bonds than bonds that keep their rating. A lower rating (emanating from a bond that was downgraded) implies a higher chance of defaulting, without actually implying that the issue will default. Therefore, the issue carries a higher default risk due to increased uncertainty, or probability, of default. This requires a higher premium to cover, even for a portfolio-scenario.

[28] Another perspective on default risk might be “jumps” (jumps-to-default or jump-diffusion-process) as found in articles wishing to explain yield premiums through the utility of structural models; see for instance Delianedis and Geske (2001) and Huang and Huang (2003).

If the implication of "return" in the context of the bond market is considered, and it is taken that the investor for example invested in an A-rated issue that was downgraded to a Baa-rating, then it becomes clear that he would have paid a price comparable to other A-rated bonds, but can now only expect the return on a Baa-rated bond for some part of the lifetime of the issue that was initially A-rated.[29]

Considering that most studies investigating bond yield spreads compute default risk at the issue's current credit rating (and not at probable credit ratings), the loss in returns is not covered by the risk premium the investor commanded for default risk at its issue.[30] The default risk premium moves with the rating and the former will be one of the probable reasons why the bond's spread ought to increase as the issue is downgraded; after being downgraded, the downgraded issue has a lower rating representing a higher default risk premium.

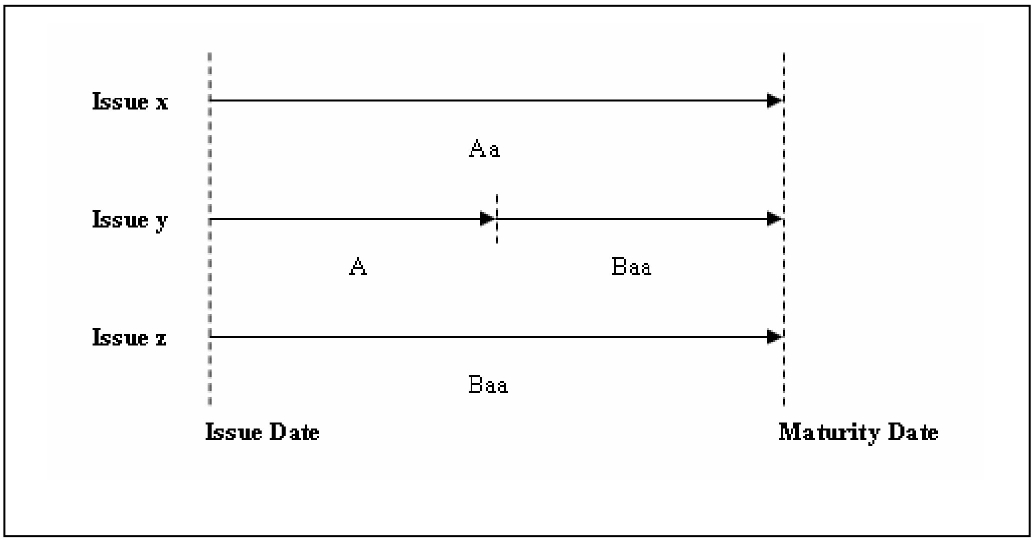

Figure 7. A hypothetical issue's rating over its lifetime and the implied price

[29] If portfolios are formed based on credit rating, as Foss (1995) suggests, the downgraded issue should now effectively belong to a lower quality portfolio, and this portfolio's likelihood that one of its members will default, irrespective of which member, is higher. This in turn results in higher default losses and therefore lower returns over the price paid to construct the portfolio – the downgraded issue transitioned from a higher priced portfolio. Thus, when portfolios are constructed, a premium is required per portfolio member (issue) as compensation, should an issue later-on transition to a lower-quality portfolio.
[30] A possible exception on the point is Elton et al (2001), through their consideration of a rating transition matrix.

Thus, it should be carefully examined whether the default risk premium calculation already includes a downgrade-risk premium. Figure 7 shows a hypothetical issue y that is downgraded from an A-rating to a Baa-rating at the midpoint of its lifetime. Consider how (the default risk component of) issue y in Figure 7 would have been priced if the rating-pattern in Figure 7 was known in advance.[31]

The second perspective is similar to the first, but relates to marketability of the bond and capital losses. This perspective considers that downgraded bonds result in capital losses. Should an issue be downgraded, the investor is forced to reconsider the marketability of the bond – if he immediately or soon after the downgrade wishes to sell the issue, it will be at a capital loss as the bond is immediately worth less after (around) the downgrade. If he holds on to the issue, he has the chance that the resultant capital loss would be less, but this is at an increased risk that the bond will default in its lifetime.[32] The downgrade marked an increased discrepancy between promised cash flows and expected cash flows and the investor is carrying it without any compensation for it.

Dynkin et al (2002) offer ways to quantify downgrade risk; it has been discussed in a previous paragraph. In general, downgrade/ upgrade probabilities should be noted over the lifetime of an issue and against different issue qualities - probabilities will differ for different quality bonds. Just like plain default risk, exposure to downgrade risk can not be fully eliminated through diversification; therefore, downgrade risk is added to Equation [3].

Next, Equation [4a] is rewritten by considering that Maturity probably impacts other determinants more than it is a determinant on its own; similarly, Issuer Sub-categories are probably relevant because they capture the effect of

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[31] Furthermore, consider the percentage of total issued bonds that retire without having defaulted. Next, consider how many of the issues that do retire without having defaulted, do retire with a different rating than what was originally assigned to it at issue. Also, consider how many of the issues that do retire without having defaulted, do retire with the same rating it was initially issued with, but that did not keep their rating throughout their lifetime. For the latter two arguments, consider how many are lower rating cases, as opposed to higher rating cases. See for instance Hamilton and Cantor (2004) for further examples of rating transitions.

[32] The investor is in fact betting that the assessment of an increased default probability is incorrect. By holding the issue to maturity, the investor essentially hopes to still receive cash flows at the default risk (default probability) prior to the downgrade.

business cycles – which in turn is captured by ratings. Furthermore, ratings are written as proxies for default risk, variation in default risk – which is simply downgrade risk, recovery rates, and the effect of business cycles on the issuer.

Note two potential issues arising out of this: a) in rearranging the terms, it is assumed that real impacts or contributions are not distorted by rearrangement – for instance, with writing *Business Cycle* under Rating, it is assumed that Ratings correctly capture the complete effect of Business Cycles on the Issuers. b) Similarly, Maturity is redistributed under Systematic Risk and Default Risk; the distribution should not distort the effect of Maturity. The redistribution also assumes that Maturity mostly contributes to default risk and Systematic Risk – is this correct? In addition, do agencies specifically and completely capture the effect of maturity on default risk?

$$Yield\ Spread_i^{corp} = \int \left\{ \begin{array}{l} Maturity, Taxability, Liquidity, \\ Issuer\ Subcategory(Business\ Cycle), \\ Default\ Risk(Rating(Default\ Probability, Recovery\ Rate), Maturity), \\ Temporary\ Demand\ and\ Supply\ Imbalances, \\ Systematic\ Risk(Issuer\ Subcategory, Rating, Maturity), \\ Downgrade\ Risk(Rating, Issuer\ Subcategory, Maturity) \end{array} \right\} \quad \textbf{[4a]}$$

$$Yield\ Spread_i^{corp} = \int \left\{ \begin{array}{l} Taxability, \\ Liquidity, \\ Temporary\ Demand\ and\ Supply\ Imbalances, \\ Systematic\ Risk(Issuer\ Subcategory, Rating, Maturity), \\ \\ Default\ Risk\left(Rating \left(\begin{array}{l} Default\ Probability, \\ Downgrade\ Probability \\ Recovery\ Rate \\ Issuer\ Subcategory(Business\ Cycle) \end{array} \right), Maturity\right) \end{array} \right\} \quad \textbf{[4b]}$$

Although Equation [4] is evidently over-simplified[33], it already offers some basis to analyse the correlation between bond prices and bond ratings. In

[33] Many of the factors and sub-factors listed in Equation [4] actually vary with time. For instance, default probabilities, recovery rates, and downgrade risk (rating transition probabilities) can all vary with time.

comparing Equation [3] and Equation [4], the three major determinants of Equation [4] should remain more or less the same as those reported under Equation [3]: Taxability; Systematic Risk; and Default Risk.

With regards to the weight of determinants, the real difference between Equation [3] and Equation [4] is that Equation [4] incorporates downgrade risk – whereas Equation [3] does not, at least not explicitly. True default risk is seen to incorporate both the risk of default and the risk of downgrade (variation in default risk). Default risk under Equation [3] more or less follows the calculation of Elton et al (2001). Default risk under Equation [4] considers the work and calculation of Dynkin et al (2002) over and above the calculation of Elton et al (2001). Elton et al (2001) does incorporate downgrade risk to some extent, by considering rating transitions. Unique about Dynkin et al (2002) is that risk of downgrade is calculated over the lifetime of the issue - as opposed to merely a part of the total lifetime.

Thus, the contributions of determinants listed under Equation [4] should more or less follow the contributions of determinants listed under Equation [3], to the extent of the difference between default risk - as calculated by Elton et al (2001) – and the sum of default risk – probably as calculated by Bennett et al (1994) – and total downgrade risk – as calculated by Dynkin et al (2002).[34] Should such a difference exist, it has the potential to upset the calculated tax premium as well (together with the Systematic Risk weighting) – under Equation [3] the tax premium was reported as constituting ≈36% of the total bond premium.

The paragraph above sketches a triangulation of results or calculations: Elton et al (2001) on the one hand, and Bennett et al (1994) together with Dynkin et al (2002) on the other hand. Given the true meaning of Credit Default Swaps (CDS), the triangulation can be further extended by also referencing CDS spreads (see for instance Hull et al 2004). After triangulating the calculations of Elton et al (2001), Bennett et al (1994) and Dynkin et al (2002), the result or

[34] In essence, add the calculations of Bennett et al (1994) and Dynkin et al (2002). Next, subtract this from the calculation of Elton et al (2001) and note the potential difference.

outcome ought to compare with CDS spreads; after also correcting for additional differential tax treatments induced by CDS – from the perspective of issuers and investors.

Other Risks associated with investing in Bonds

List B presents several risk factors associated with investing in bonds, as detailed by Fabozzi (2000) and Fabozzi (1995). For purposes of triangulation and in the interest of consistency, the factors from the list should either be present - in one form or another - in the factors listed in Equation [3] and Equation [4], or a logical explanation should exist for their omission. Definitions of the risks are obtained from the sources.

List B – Risks associated with investing in bonds

1. Risk-Risk **	2. Exchange-rate risk **
3. Volatility risk **	4. Call risk **
5. Liquidity risk **	6. Default risk **
7. Reinvestment risk **	8. Political/ legal risk *
9. Yield curve/ maturity risk *	10. Event risk *
11. Sector risk *	12. Inflation risk **
13. Interest-rate risk **	

Sources[35]: Fabozzi (1995) *; Fabozzi (2000) **

Risk-Risk relates to poorly informed investors and is ignored. Next, Exchange-rate Risk, Volatility Risk and Call Risk are also ignored as these factors mainly influence foreign denominated bonds and bonds with special features; both types have been excluded from discussion in this section. Liquidity Risk is in

[35] In both sources, these risks are listed in introductory chapters.

fact present in both Equation [3] and Equation [4]; so is Default Risk. Reinvestment Risk concerns the reinvestment of coupon payments; its relevance to this section is questioned.[36]

Political/ Legal Risk refers to actions by regulatory bodies that adversely affect the value of the security, therefore resulting in capital losses and/ or fixed income losses. Fabozzi (1995) offers examples of how Political/ Legal Risk can result in sudden capital losses – for example, how a change in bond-tax legislation (tax-exempt issues are suddenly taxed for instance) immediately impact bond prices.

An investigation into the effect of Political Risk/ Legal Risk on bond prices is somewhat outside the scope of this study. In contrast to abrupt legislation changes – the sudden capital losses spoken of by Fabozzi (1995) – the "refined" side of Political/ Legal Risk will very likely affect economic stability, business conditions and interest rates. Therefore, it appears to be a determinant of risk-free term structure uncertainty. Regardless, Political/ Legal Risk probably only concerns corporate issues if it impacts their default risk – default probabilities, variation in default probabilities, and recovery rates – over and above impacting the risk free rate (term structure). In this regard, see also Indirect Sovereign Risk as coined by Peter and Grandes (2005). Assume that Default Risk in Equation [3] and Equation [4] incorporates the relevance of Political/ Legal Risk to corporate issues.

Yield-curve/ Maturity Risk involves the adjustment that is made to account for differential interest rates in two bonds; according to Fabozzi (1995), in many situations, a bond of a given maturity is used as an alternative to another bond of a different maturity. Again Yield-curve/ Maturity Risk together with Inflation Risk, and Interest Rate Risk seem to be related to term structure uncertainty

[36] The risk is stated as the risk that future reinvestment rates will be less than the yield to maturity at the time the bond is purchased. Although it is understandable that reinvesting coupons can improve yields (yield-to-maturity), the relevance of reinvestment risk to this section is questioned. It seems as if Reinvestment risk relates to the decision to reinvest coupons with banks instead of other sources, i.e. the competitiveness of various investment options. It is unclear why exactly it is seen as a risk specific to bonds and it is proposed that it is better explained and captured as part of market uncertainty regarding the risk-free term structure.

over a certain period (possibly the maturity of an issue). Term Structure Uncertainty is revisited in a subsequent paragraph.

Event Risk is defined as occasional serious changes in the ability of an issuer to make interest and principal payments. Reasons given for event risk are: a) a natural or industrial accident, or b) a takeover or corporate restructuring. Sector Risk is seen as differences in the responses of bonds in different market sectors to environmental changes; the possibility of adverse differential movement of specific sectors of the market.

Both Event Risk and Sector Risk appear to represent a general unsystematic (random) risk component. It appears as if Sector Risk also parallels with Business Cycles. Exposure to Event Risk and Sector Risk can probably be reduced through diversification; although diversification cannot eliminate these risks' effect on the total bond market. Interestingly, Event Risk appears to be rather random of nature; Systematic Risk probably less so. Therefore, Event Risk may thus contribute a random element to Default Risk in terms of Default probabilities and Variation in Default probabilities, albeit probably of small degree/ magnitude. Assume that in Equation [3] and Equation [4], Event Risk is incorporated in Default Risk and Sector Risk in Business Cycles.

Changes in inflation and interest rates during the lifetime of a bond will change the required base interest rate and therefore the required yield on the bond. Inflation Risk and Interest-rate Risk are seen to be closely related; both impact the base interest rate. An important point emanating from the utility of spot rates (see for instance Elton et al 2001; and Elton et al 2003) is that Inflation Risk and Interest-rate Risk really just create variation and thus uncertainty in risk-free spot rates. Both are also only relevant over the period of any bond, whether corporate or more risk-free bonds like government bonds.

Interest-rate risk is purported as a great risk to bonds, but how extensive is the growth in risk-free term structure uncertainty over maturity? In addition, it is unthinkable that investors will not require a premium as compensation for term structure uncertainty. Whether Floating-rate bonds, as well as other investment options, can (actually) reduce term structure uncertainty is another question altogether.

When Assuming perfect transparency between risk-free bond pricing and corporate bond pricing – what is known to risk-free bond investors, including the shape of the risk-free term structure, is also known to corporate bond investors – Inflation Risk and Interest-rate Risk really only seem to affect corporate issues in terms of their implications; risk-free term structure uncertainty has implications – uncertainty is rooted in elements and factors. Therefore, assume that Equation [3] and Equation [4] capture the possible ripple-effects of term structure uncertainty through Business Cycles and thus Default Risk.

As a final point, it is noted that this section has predominantly built on research that had been conducted on bond-markets of developed countries, most notably the US bond market. This study assumes that the bond price determinants in developing countries are more or less the same than the bond price determinants in developed countries; the determinants may carry different (greater) weights though. Term structure uncertainty for instance ought to be higher and the market may be less diverse in terms of issues and issue-characteristics. Liquidity- and/or other premiums may somewhat differ if diversification (portfolio construction) is more difficult in developing countries due to fewer issues within a certain class and industry sector - see for instance Dynkin et al (2002) for an indication of how this can influence optimal portfolio construction. Also, premiums attributable to Systematic Risk and Default Risk may differ as well, given the possibility of totally different market contexts.

2.2.1 *Conclusion*

This section reviewed a list of bond price determinants - in an attempt to construct a break-down of the contributions of individual bond price determinants to total bond premiums. The relevance of this is that it makes it possible to allude to and examine the percentage of bond premiums under discretion of ratings (rating agencies), and the percentage of bond premiums likely to be under the sole discretion of ratings (rating agencies), at least to some extent. Sole discretion implies that discretion over the particular determinant is not likely shared by other market participants and also implies proprietary access in some way.

The bond price determinants examined were: Maturity; Liquidity; Taxability; Issuer-Subcategory - which is seen as related to Business Cycles; Supply & Demand Imbalances; Systematic Risk - as measured by Elton et al (2001); Default Risk. Furthermore, Default Risk is seen to incorporate Downgrade Risk as well; Default Risk is thus about Default Probabilities; variation in Default Probabilities (downgrade probabilities); Recovery Rates in the case of default; and likely even Maturity.

Related to this, it appears as if some of the bond price determinants are captured as bond price determinants truly because they impact Default Risk, by impacting Default Probabilities and/ or variation in Default Probabilities. Maturity; Issuer Sub-category; and Business Cycles are good examples. In addition to this, Event Risk; Sector Risk; Political/ Legal Risk; and the ripple effects of Term Structure Uncertainty were also considered to be secondary factors or determinants affecting Default Risk. Most if not all of these determinants are probably under the discretion of credit rating agencies; Maturity may be an exception.

The Relationship between Credit Ratings and Bond Prices; the percentage of Bond Premiums attributable to Credit Ratings

The correlation between bond prices and ratings seems to be centred on default risk – thus default probabilities and variation in default probabilities (downgrade probabilities); the probability of default is also exactly what differentiate risky bonds from riskless bonds.

Certain bond price determinants clearly amplify the relationship between bond prices and credit ratings – by removing these determinants, a totally different result is achieved.[37] It should thus be asked whether these determinants are directly influenced by credit ratings or rather indirectly. To be under direct influence, the (factors of the) determinant should be under the direct control or rather discretion of the rating agency.

Taxability is a good example of an amplifying determinant not influenced by credit ratings. Although the credit rating agency can impact the bond price and thus tax premiums through its assessment of default probabilities, it cannot directly decide on tax premiums. Similarly, movements in its tax premium won't necessarily cause credit rating agencies to assign a different rating to an issue. "Systematic Risk" as measured by Elton et al (2001), may likely also be an amplifying determinant. It is however not clear whether it is under the direct discretion of credit rating agencies.

In contrast, it seems unlikely that some of the other bond price determinants, like Supply/ Demand conditions (Athanassakos and Carayannopoulos 2001) and Liquidity, impact the correlation between bond prices and credit ratings – are higher rated issues more liquid and in greater demand than lower rated issues, by a large extent? Regardless, these determinants are not under the discretion of ratings (rating agencies).

Therefore, to summarize the above, the instances of risk that credit ratings appear to provide information on are most likely: *Default Risk* (Default Probabilities; Variation in Default Probabilities; Recovery Rates); and related to this – the effect of *Business Cycles* on the Issuer, according to the *Issuer-Subcategory*. This probably excludes: *Liquidity*; *Supply/ Demand Conditions*; *Taxability*. The following are more difficult to review: "*Systematic Risk*" of Elton et al (2001) and *Maturity*.

[37] Amplification can be seen (gauged) by noting the change in bond-premium contribution made by the particular factor, for each notch change in credit rating.

The above also gives some indication of the possible impact and then possible independent impact ratings can have on bond prices. More specific, the contribution of instances under discretion of ratings (rating agencies) and the contribution of instances *possibly* under discretion of ratings (rating agencies) indicate the percentage or portion of bond prices under discretion of credit ratings. As an elementary case, if rating agencies only have discretion over x bond price determinants, and the x determinants - in a collective capacity - directly contribute y% to total bond prices and indirectly contribute z% through secondary determinants (for instance tax), then rating agencies more or less only have a y% direct and z% indirect total ascribable potential impact on bond prices.

In terms of sole impact (s), percentages representing the ability of markets to form their own discretion on the x determinants under discretion of credit ratings should still be subtracted from the direct impact (y%). For instance, consider Default Risk comprising of Default Probabilities, Variation in Default Probabilities, and Recovery Rates. Recovery Rates represents a significant contributor of Default Risk – as opposed to an insignificant contributor. Given that markets can form their own independent opinion about Recovery Rates, sole impact (s%) is likely to be less than direct impact (y%) - (s < y).[38] Systematic Risk as bond price determinant is another excellent example – the way it is measured by Elton et al (2001) clearly entails that the market does not need the assistance of rating agencies to calculate the relevance of this determinant.

Equally important to keep in mind is that, although ratings may signal information about other instances of risk, it does not constitute a risk itself. Therefore, any premium attributable to the rating is actually attributable to the underlying instances of risk the rating is reflecting on.

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[38] It does not seem likely that sole impact (s) can be equal to direct impact (y). $(\therefore\ s < y; s \neq y)$ Consider the case where the market feels agencies do not have sole discretion over certain bond price determinants, but nevertheless outsource "discretion" over certain determinants to agencies. This potentially reduces the ability of participants who outsource to agencies to beat the market by forming opinions more quickly than the market. Put differently, it seems as if discretion over determinants may provide competitive advantage. This in turn may reduce willingness to outsource if sole discretion does not exist. Therefore, sole discretion seems to be a requirement for agencies to "play" in (contribute to) the market.

The discussion thus far is congruent with the deduction that the level of price change that can be expected in the wake of a rating change is related to the ordinary difference in the premiums associated with the different ratings involved in the rating change (pre-rating; post-rating).

As a grand summary, when raising the relationship between Credit Ratings and Bond Prices, it may be helpful to differentiate between Indirect Impact; Direct Impact; and Sole Impact, by referring to bond price determinants – Refer to Table 2. Although it may happen that determinants are: a) added to the table; b) removed from the table; c) redistributed among the columns of the table; and d) the weightings of determinants are updated, it is doubted whether the table itself will change in terms of layout.

Table 2. Relationship between Credit Ratings and Bond Prices

<table>
<tr><th colspan="4">Credit Ratings | Bond Premiums</th><th></th></tr>
<tr><th>No Impact</th><th>Indirect Impact</th><th>Direct Impact</th><th>Sole Impact</th><th rowspan="2">Bond Price Determinants*</th></tr>
<tr><td>• Liquidity
• Supply/ Demand Conditions</td><td>• Taxability (≈36%)</td><td>• Default Risk (≈18%)
•Default Probabilities
•Downgrade Probabilities [Variation in Default Probabilities]
•Recovery Rates
•Maturity
• Systematic Risk (≈39%)</td><td>• Can only stem from determinants listed under Direct Impact
• Likely excludes Systematic Risk
• Potentially excludes Recovery Rates, Maturity</td></tr>
</table>

* Weightings based on previous research reviewed under the preceding section, notably that of Elton et al (2001).

The possibility of price developments prior to the Rating Announcement

It can probably be insinuated that, should a rating be changed, the issuer or issue experienced or is experiencing a change in its default probability and/or variation in default probability, and that it may be ascribable to changes in current or forecasted business cycles - although not in all cases. What other factors may influence such a judgment is good to know; what is meant is: the credit rating agency changed the rating, because it felt/ calculated/ forecasted that x changed, over and above the business cycle… [Event Risk and Sector Risk are naturally also some possibilities.]

As alluded to by excerpts of the work of Dynkin et al (2002:91) and further revealed in the next section, certain financial ratios play a role in the allocation or assignment of ratings. The question above is somewhat different though, it enquires about the determinants of Default Risk[39], not ratings – this may or may not be the same question. Nevertheless, knowledge of either will greatly help to predict whether price developments prior to rating announcements are possible. Both Manzoni (2004) and Vassalou and Xing (2004) have already started addressing the determinants of default probabilities in some way; Vassalou and Xing (2004) are introduced in the next section.[40] Whether price developments prior to announcement are possible really depends on the extent to which the market can form independent opinions about determinants under the discretion of ratings (rating agencies) – in essence, the magnitude of sole impact, s.

[39] This in effect refers to the determinants of: a) Default Probabilities, b) variation in Default Probabilities, and possibly c) Recovery Rates, d) Maturity. Given that Maturity is known and fixed after the issue date, it seems as if Maturity rather captures exposure to the probable determinants of a) to c) above; rather than having determinants of its own.

[40] On this point, it can be mentioned in passing that Manzoni (2004) proposes a downgrade forecasting model, citing that although a variety of default and bankruptcy prediction models have been proposed in the literature, little research has been carried out in the field of downgrade prediction yet.

2.3 The Independent Impact of Credit Ratings on Bond Prices

A view on rating agencies is that they perform a specialist function; that they might achieve economies of scale and therefore offer a specific benefit to investors (see for instance Ederington 1984; Steiner and Heinke 2001). Also, it is believed that rating agencies make it possible for companies to channel private or inside information, that might otherwise benefit competitors, to investors and such (see for instance Ederington 1984; Hsueh and Kidwell 1988; Kliger and Sarig 2000).

On the other hand, Livingston et al (2003:4) - by referring to statistical models in general - together with Chan and Jegadeesh (2004:157) - by referring to Multiple Discriminant Analysis (MDA) as part of rating prediction models - make note of the "relative success" of previous research in explaining or predicting bond ratings.

Chan and Jegadeesh (2004) note that work building on Pinches and Mingo (1973) can correctly predict 70% of ratings – Pinches and Mingo (1973) could correctly predict 60% of ratings. By referring to Kaplan and Urwitz (1979), Livingston et al (2003) note that much academic research – in using various statistical models to predict bond ratings by several observable economic and financial variables - find that (only) 50% to 70% of bond ratings can be explained by a few public available variables.[41] Other examples of bond rating prediction models with relatively high prediction success rates are the work of Kumar and Haynes (2003)[42] and Chan and Jegadeesh (2004)[43].

"Private Information" as constituent of ratings

The work of Ederington et al (1984); Reiter and Ziebart (1991); and Livingston et al (2003), address the roles of bond ratings and financial information in the

[41] Note that this particular line is referred to by a subsequent paragraph…

[42] The study examined bond ratings in India and obtained a success rate of 70% (52.6%) using an Artificial Neural Network [ANN] (Discriminant Analysis).

[43] The study's success rates vary between 75% and 86% using various statistical prediction models: 86% of agency ratings can be correctly replicated by MDA; 75% by MDA-C; 79% by Probit; and 75% by Probit-S. The abbreviations are delineated subsequently.

setting of bond yields. Livingston et al (2003) further notes that the remaining 30% to 50% of the variations in bond ratings not explained in the statistical models[44], may be due to other public information not controlled for in the models, rather than private information rating agencies may have.

In review of the work of Reiter and Ziebart (1991), Ederington et al (1984) - and other related, earlier research - Livingston et al (2003:6) note that though these studies consistently find that bond ratings have an impact on bond yields above and beyond several observable financial or economic variables, they fail to directly address the question of whether bond ratings contain information that is not publicly available. Livingston et al (2003) further offer three explanations consistent with the findings:

1. bond ratings contain publicly available information not captured in the few selected variables in the studies;
2. bond ratings may have an impact on bond yields due to their role as regulatory tools even if they do not have private information;
3. bond ratings have private information.

In essence, and of great importance to this particular study, Livingston et al (2003) do not question that bond ratings impact bond yields, but wish to enquire into the extent by which this impact is directly attributable to the bond rating itself, instead of merely indirectly attributable due to the high correlation between bond ratings and bond yields.

Livingston et al (2003) studied the impact of Private Information as independent variable on Bond Ratings as dependent variable, by using the Latent Variable Technique.[45] More specifically, they constructed a simple bond rating latent variable model with only one unobservable variable: Default

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[44] The initial statement is captured in this document and earmarked by a previous note, note 41.

[45] The Latent Variable Technique (LVT) allows the estimation of coefficients on unobservable latent variables, even if the variables cannot be measured. Several techniques can be used to estimate the model – Maximum Likelihood (ML), Weighted Least Squares Techniques (WLS) (ML and WLS – indicator variables are continuous) as well as Categorical Variable Method (CVM) (CVM – some of the indicator variables are categorical variables) (Livingston et al 2003:14).

Risk (DR). Based on previous research's variables, four proxies for Default Risk were used: Interest Coverage Ratio, Leverage Ratio, Firm Size and Return-on-Assets (ROA).

A more comprehensive model was also constructed by adding a latent variable for Private Information to the simple model. Two classes of proxy variables for information asymmetry were used: Corporate Finance based and Market Microstructure based. Firm size and Analysts' Forecast Error were used as proxies for the former, and Adverse Selection as a proxy for the latter. In the simple model, the dependent variable, Bond Rating, is only covered by one latent variable, Default Risk, whereas in the second model, Bond Rating is covered by two latent variables, Default Risk plus Private Information.

The subsequent logic of the study is thus that, should bond ratings contain private information, then the coefficients of proxies for Private Information should be significant. Secondly, if bond ratings contain private information, then the second, more comprehensive model should explain more of the variation of bond rating than the simple model. Lastly, to test whether the market actually prices Default Risk and Private Information, another dependent variable - Yield Premium - covered by the two latent variables, Default Risk plus Private Information, was included.

The study found that the three proxies for Information Asymmetry, *Firm Size*; *Analysts Forecast Errors*; and *Adverse Selection Components* were related to the unobservable *Private Information*. Specifically, large firms tend to have less private information, while firms with large forecast errors and adverse selection components have more private information. Also, the Private Information variable had an impact on bond rating and this suggests that large information asymmetry has a negative impact on bond ratings irrespective of the rating agency.[46]

The model output, the coefficient of determination (R^2-value), on the bond ratings in the WLS estimation (CVM estimation) increased from about 55%

[46] The study separately used ratings from both Moody's and Standard and Poor (S&P).

(64%) in the simple model to 61% (72%) in the Private Information model. This indicates that the additional Private Information latent variable has significant additional explanatory power on bond ratings. For the Standard & Poor (S&P) regression in the WLS (CVM) estimation, Default Risk reflected in the public information accounted for 56% (66%) of the variation of the bond rating and the private information reflected in the three information asymmetry proxies accounted for 5% (6%). For the Moody's regression in the WLS (CVM) estimation, the two latent variables accounted for 54% (67%) and 8% (9%) of the rating variations respectively. Hence, it seems that the private information plays a relatively smaller role in bond ratings. Based on this, Livingston et al (2003) concludes that it is not surprising that some of the previous studies fail to find evidence that bond ratings have impact on yields after controlling for public information.

Moving on to bond premiums, for the model with Standard-and-Poor's ratings estimated by the WLS (CVM) method, Default Risk accounted for 33% (30%) and Private Information accounted for another 8% (8%) of the variation in bond yield premiums. For the model with Moody's rating estimated by the WLS (CVM) method, the two variables accounted for 32% (28%) and 8% (7%) of the bond yield premiums respectively.[47] [48]

In their study, it made sense to separately process the ratings of Moody's and Standard and Poor, for more than one reason. By using a sub-sample of observations that had split ratings at the notch level, it became clear that the coefficients of Private Information were much higher than usual, suggesting that large information asymmetry makes it harder for rating agencies to agree upon the issuing firm's creditworthiness. At the same time, the coefficients of

[47] As noted a few paragraphs back, Private Information is partially captured by the proxy Firm Size. Recall from section 2.2 that Elton et al (2001) accounted for Systematic Risk as a bond price determinant through the three Fama-French (1993) factors. One of these factors essentially builds on firm size.

[48] The weight of Default Risk is relatively higher than accounted for under Section 2.2. In this case, Default Risk as independent variable was again partially captured by Firm Size; the particular study does not differentiate between Default Risk and Systematic Risk (see Elton et al 2001). With reference to the proxies this particular study used to capture Default Risk, the study quantifies Default Risk differently to some of the studies mentioned under Section 2.2. This also introduces the possibility that other bond rating prediction models, already achieving high success rates, might also see default risk and other bond price determinants in a different light than rating agencies. Particularly, it should be asked whether these models can't be improved by the better separation and accounting of various bond price determinants; do these models for instance incorporate Downgrade Risk with Default Risk?

Default Risk remained largely unchanged. More specifically, for the whole sample, Private Information only explained 5%-9% of the variations in ratings, while Default Risk accounted for almost 58% to 70% of the variations. For the split-rating sub-sample, Private Information accounted for a much larger proportion of the rating variations than the whole sample - ranging from 11% to 17%.

A dummy variable representing split-ratings was incorporated into the full model to statistically test whether private information plays a significantly larger role in bond ratings for issues with split ratings,. The coefficients on Private Information in the split dummy variable equation were positive and significant, suggesting that larger information asymmetry makes it more likely to have split ratings. The coefficients on Default Risk in the split dummy variable equation were not significant, suggesting that split ratings are not caused by a different interpretation of public available accounting information.[49]

Investors' (over) reliance on credit ratings

The work of Chan and Jegadeesh (2004) is also remarkable in that they question the bulk of the literature that utilize agencies' ratings in an attempt to predict corporate bond ratings through the use of various statistical models, because these studies benchmark on rating agencies to evaluate their respective rating prediction models. Chan and Jegadeesh (2004) argue that these studies assume that agency ratings provided by Moody's or S&P are good proxies of default risk regardless of the evidence that agency ratings may not be accurate in a timely fashion.

Assuming that the market can form an independent assessment about default risks of bonds, Chan and Jegadeesh (2004) propose a new approach to evaluate models in predicting true bond ratings. In more detail, they

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[49] As a final note on the work of Livingston et al (2003): Livingston et al (2003) admit that their model is not perfect and all-inclusive, and they note how they have dealt with two potential problems regarding the underlying assumptions of their model: that the error terms are uncorrelated with each other and that the Private Information variable is not reflected in the other three publicly available accounting variables.

constructed a relative rating strength portfolio formed by buying under-rated bonds, whose Moody's ratings were lower than predicted ratings from the statistical model, and selling over-rated bonds, whose Moody's ratings were higher than predicted ratings. They held this portfolio for five years after the rating predictions, and examined its long-run performance. Their argument was that, if one statistical model could identify misclassified bonds which generate significant higher returns than bond portfolios based on other models, the model had more power to detect bonds whose agency ratings deviate from true ratings and it is therefore a better model in predicting bond ratings.

Chan and Jegadeesh (2004) reported the following results: the accuracy rate for the Multiple Discriminant Analysis (MDA) model was about 86%, which is higher than that in previous studies.[50] The Multiple discriminant analysis with the cross-validation holdout procedure (MDA-C) model also performed well and dominated similar models in earlier research, with an accuracy of 75%. In citing Pinches (1980), the authors note that the error rates of MDA-C are proved to be unbiased and relatively robust, and therefore, the result they obtain indicates that at least three-fourths of the Moody's ratings can be replicated by their models.

Furthermore, for raw returns, all models generated significant returns in the long-run. In particular, over five post-formation years, the relative rating strength portfolio earned an average return of 11.89% from MDA; 9.9% from MDA-C; 9.57% from a Probit-model; and 8.35% from an Ordered Probit with Stepwise variable election model (Probit-S), all of which were significant within the 1% level. However, after controlling for the bond market returns, only MDA-C and Probit-S (can) generated significant abnormal returns in the long-run. The relative rating strength portfolio based on MDA-C even outperformed

[50] According to Chan and Jegadeesh (2004), the superior performance is probably attributable to the fact that they include more variables in their models and that they exclude the subordinated bonds from the sample. Also, they perform the rating prediction in a year-by-year basis, rather than pooling many years together in the training sample as previous studies do, thereby making good use of all available information.

that from Probit-S - starting from year two - and generated an abnormal return of 5% over five years.

In conclusion, the authors note three implications based on their results. Two of these are related to (the relative performance of) bond rating prediction models – the superiority of MDA-C; and the importance of adopting the hold-out procedure (see MDA versus MDA-C) in rating predictions, as well as the stepwise variable election (Probit versus Probit-S). More important to this study is the final implication that the bond market was not as efficient as the authors had expected.

"…the major participants of the corporate bond market are institutional investors who are expected to be sophisticated and informed, therefore, the corporate bond market should be quite efficient. However, the existence of a profitable trading strategy based on MDA-C suggests that the corporate bond market is not as efficient as expected. One possible reason is that investors rely too much on agency ratings, and the revision process of these agency ratings is too long." (Chan and Jegadeesh 2004:168)

Multiple ratings; Split Ratings

Ederington (1986) offers three possible explanations why split ratings (may) occur. First, the agencies may agree on the creditworthiness of a bond (i.e., may agree on the probabilities of various degrees of default), but assign different ratings because they have different standards of creditworthiness for a particular rating. Second, their evaluations of an issue's creditworthiness may differ because of systematic differences in their rating procedures - that is, the two agencies may consider different factors or assign different degrees of importance to the same factors when deciding on a rating. Third, there may be no systematic differences between the two agencies but, because evaluating creditworthiness is a difficult, subjective task, some non-systematic variation in raters' judgments occurs from issue to issue and day to day. Particularly when an issue's creditworthiness lies close to the cut-off point between adjacent ratings, split ratings may occur because of these random variations in judgment.

Ederington (1986) further notes that an analysis of split ratings offers insights into the nature of bond creditworthiness evaluation and into the informational content of all ratings -split and non-split. Both Liu et al (1999) and Kliger and Sarig (2000) studied the independent impact or information value of bond ratings by examining the price reactions of bonds to Moody's refinement of its rating system. The rating refinement was not accompanied by any fundamental change in issuer's risk; was not preceded by any announcement; and was carried out simultaneously for all bonds.

In short, Kliger and Sarig (2000) found that bond prices adjusted to the new information. Liu et al (1999) found that only the sub-sample of bonds that had been downgraded showed a significant result. Secondly, the magnitude of rating revisions caused by the refinement is very minimal - only one third of one generic rating category. It is noted that all ratings are revised within the bonds' original rating categories, as opposed to across rating categories.

Hsueh and Kidwell (1988) wanted to analyze why borrowers obtain more than one credit rating for their debt. Their study empirically tests the impact of a municipality's decision to acquire a second credit rating on new issue borrowing cost when (a) the two credit ratings are the same, and (b) when the two credit ratings are different (a split rating).[51]

In doing so, the authors argue that, if borrowers are economically rational, they will purchase two ratings only when they expect it to result in a lower net borrowing cost when faced with the alternative of purchasing a single credit rating. The value of a bond rating lies in its certification of the debt issue's credit quality. If the borrower is relatively certain about the anticipated rating, there is an incentive to obtain two credit ratings only if the borrower believes that two credit ratings have a stronger certification effect than one credit rating - the so- called double confirmation effect.

[51] The findings of Hsueh and Kidwell (1988) suggest that two credit ratings provide additional information and that split rated bond issues account for reduced borrowing costs. The study found that municipalities that purchase a second credit rating for their new bond issues reduce their borrowing cost by 5.2 basis points if the two bond ratings are identical. When the two credit ratings are different, split rated bond issues sell at interest cost below comparable issues with the adjacent lower credit rating. The interest cost savings in these cases range from 16 to 21 basis points.

Therefore, a bond issue with two identical credit ratings is expected to have a lower borrowing cost than a comparable bond issue with a single credit rating. If a bond issue has a split rating, investors may interpret the second rating as providing some previously unknown information about the bond's credit quality that the first rating did not convey.

From the demand side, investors may treat split rated bonds as having a credit quality falling somewhere between the two divergent credit ratings. From the supply side, borrowers must be convinced that split rated bonds will not be priced at the lower of the split ratings. Otherwise, there would be little reason to obtain a second rating. If the borrower is not certain about the anticipated bond rating, risk aversion may provide some incentive to obtain two ratings. The issuer may want to apply to both rating agencies in order to increase the probability of obtaining a higher rating. This is justified only if the net benefit of a split rating exceeds the net benefit of receiving only the lower rating.

2.3.1 *Conclusion*

Rating Prediction Success and Residual Uncertainty in terms of the Determinants of Ratings

The relatively high success rates with which bond ratings can be predicted through the utility of public information suggests that private information may only be minimally present in assigned ratings.

In addition, the non-zero error rate of prediction models suggests that ratings may contain private information – as long as ratings cannot be fully predicted, it may very well be that the proposition that ratings contain private information cannot be refuted or disproved.

The effect of residual uncertainty in terms of bond rating prediction is to create Rating Uncertainty – with zero residual uncertainty bond rating prediction models will achieve 100% success rates and ratings will be certain before they are even published; as long as residual uncertainty holds (i.e. ≠0), ratings cannot be said to be fully certain at all times.

[Depending on the level of trust the market has in ratings; Rating Uncertainty may also result in bond price uncertainty. The possibility of a bond rating announcement invokes the possibility of a bond price change.]

The relationship between Private Information and Rating Uncertainty

Given that it is likely (cannot be refuted) that residual uncertainty resident in bond rating prediction may also be due to Private Information, it is also likely that Private Information may invoke Rating Uncertainty – as delineated in the previous paragraph, the inability to predict ratings at all times.

Table 3. Accuracy Rates of Bond Rating Predictions

		MDA				MDA-C				Probit				Probit-S			
Yr	No	U	O	Mis	Accuracy	U	O	Mis	Accuracy	U	O	Mis	Accuracy	U	O	Mis	Accuracy
74	51	0	0	0	100.00%	7	3	10	80.39%	0	0	0	100.00%	4	2	6	88.24%
75	73	1	1	2	97.26%	9	8	17	76.71%	1	2	3	95.89%	3	6	9	87.67%
76	88	1	2	3	96.59%	5	7	12	86.36%	1	2	3	96.59%	6	6	12	86.36%
77	95	2	3	5	94.74%	11	8	19	80.00%	1	2	3	96.84%	7	11	18	81.05%
78	215	13	20	33	84.65%	31	27	58	73.02%	24	16	40	81.40%	26	22	48	77.67%
79	217	13	12	25	88.48%	32	21	53	75.58%	25	18	43	80.18%	29	20	49	77.42%
80	207	15	13	28	86.47%	28	20	48	76.81%	23	16	39	81.16%	26	20	46	77.78%
81	242	17	17	34	85.95%	33	26	59	75.62%	33	20	53	78.10%	25	23	48	80.17%
82	186	8	3	11	94.09%	17	8	25	86.56%	11	15	26	86.02%	13	15	28	84.95%
83	224	12	24	36	83.93%	24	32	56	75.00%	12	16	28	87.50%	18	27	45	79.91%
84	226	12	20	32	85.84%	20	34	54	76.11%	20	24	44	80.53%	25	31	56	75.22%
85	260	19	26	45	82.69%	33	36	69	73.46%	36	37	73	71.92%	43	44	87	66.54%
86	291	32	18	50	82.82%	44	26	70	75.95%	28	36	64	78.01%	31	48	79	72.85%
87	304	33	37	70	76.97%	46	45	91	70.07%	44	41	85	72.04%	39	43	82	73.03%
88	278	20	25	45	83.81%	39	40	79	71.58%	44	32	76	72.66%	45	33	78	71.94%
89	212	15	12	27	87.26%	30	16	46	78.30%	27	17	44	79.25%	21	19	40	81.13%
90	146	7	4	11	92.47%	11	11	22	84.93%	11	5	16	89.04%	16	16	32	78.08%
91	155	11	8	19	87.74%	19	20	39	74.84%	14	16	30	80.65%	29	23	52	66.45%
92	185	12	7	19	89.73%	21	15	36	80.54%	15	11	26	85.95%	20	28	48	74.05%
93	199	23	12	35	82.41%	41	23	64	67.84%	28	32	60	69.85%	32	30	62	68.84%
94	195	17	12	29	85.13%	34	18	52	73.33%	23	29	52	73.33%	27	25	52	73.33%
95	211	26	17	43	79.62%	39	37	76	63.98%	29	28	57	72.99%	36	30	66	68.72%
96	214	19	14	33	84.58%	38	25	63	70.56%	38	31	69	67.76%	44	32	76	64.49%
All	4474	328	307	635	85.81%	612	506	1118	75.01%	488	446	934	79.12%	565	554	1119	74.99%

On each April 30 from 1974 to 1996, the bonds' ratings are predicted by four models: multiple discriminant analysis (MDA), multiple discriminant analysis with cross-validation (MDA-C), ordered probit (Probit), and ordered probit with stepwise variable selection (Probit-S). The "No" column reports the total number of bonds used in rating prediction in each year. The "U" column includes the number of under-rated bonds whose Moody's ratings are lower than predicted ratings, while the "O" column contains the number of over-rated bonds whose Moody's ratings are higher than predicted ratings. "Mis" column is the number of misclassified bonds, which is the sum of numbers in "U" and "O" columns. "Accuracy" is the ratio of number of bonds, whose predicted ratings equal to Moody's rating, to total number of bonds in that year.

Source: Chan and Jegadeesh (2004)

The nature of the relationship between Private Information and Rating Uncertainty seems to be more unknown than known: Are ratings uncertain in some cases, or are ratings uncertain in all cases – do residual uncertainty exist in some cases only, or in all cases? It seems likely that residual uncertainty only exists in some cases, as opposed to all cases; in some cases ratings could be predicted by rating prediction models – refer to Table 3. Is the degree of Rating Uncertainty known; is Rating Uncertainty known to exist within a certain range – is there a pattern between probable residual uncertainty and the last rating?

This also seems likely – ratings hardly change by leaps at any time, assuming that agencies are neutral and objective in their reporting at all times. Nevertheless, it can be measured by noting the (average) rating notches by which prediction models normally over- or under-predict ratings (similar to a "standard error" measure) - per rating class[52] - and noting any traces of a pattern. In essence, calculating prediction standard errors – and its "standard deviation" - per rating class…

Thus far it seems as if the presence of Private Information may result in a degree of Rating Uncertainty, whereas a lack of Private Information may reduce the degree of Rating Uncertainty. This is shown in Table 4 below.

Table 4. Private Information and Rating Prediction Success

Private Information	Rating Uncertainty
↑	↑
↓	↓

The relationship between Private Information and Ratings

Again, if it is assumed that agencies are at all times neutral and objective in their reporting, then the utility of Private Information may have either positive (higher) or negative (lower) consequences in terms of the rating. Thus, an increase in Private Information ought to reduce rating prediction success and at the same time increase rating uncertainty either way – higher ratings or

[52] Unfortunate for this study, Chan and Jegadeesh (2004) do not post these result-statistics; this study perceived Chan and Jegadeesh (2004) as one of the most comprehensive bond rating prediction studies to provide this information, because of their cross-comparison of prediction models.

lower ratings are possible. Similarly, a decrease in Private Information ought to increase rating prediction and reduce rating uncertainty. Refer to Table 5.

Put differently, an increase in Private Information may (should) increase the discrepancy between the market anticipated rating and the posted rating; more Private Information should lead to more market surprise. In this case, "market surprise" depends on two factors: Perspective of Market Participants, including rating agencies; and very related to this – the relative trust market participants display in rating agencies.

Table 5. Private Information, Rating Prediction Success, and Rating Uncertainty

Private Information	Rating Uncertainty	Rating
↑	↑	↕
↓	↓	↕

Perspectives of Market Participants

Ratings reflect on Default Risk[53] and other bond price determinants, in doing so possibly by incorporating Private Information. Livingston et al (2003) proxied *Private Information* by means of *Information Asymmetry*. Interestingly, cases with less (lack of) Information Asymmetry have less potential Private Information than cases with more (abundance of) Information Asymmetry.

What is Private Information? Is it true to say that ratings wish to reflect on or even reduce Information Asymmetry? What does this in turn imply – that agencies can (wish to) "see through" Information Asymmetry; that agencies - through their unique position - can assist the market by being clearer on the

[53] Default Risk as outlined in Section 2.2: Default Probabilities, variation in Default Probabilities, Recovery Rates in the case of default, and even Maturity.

financial implications of Information Asymmetry on market participants? This necessitates an interpretation of Information Asymmetry – a Perspective on Information Asymmetry.

The following deductions on Perspective build on the assumption that the market is inclined to form independent opinions on bond price determinants under the direct discretion of rating agencies; during pricing, the market does not solely make use of Rating Agencies to interpret bond price determinants.[54]

The value Rating Agencies can add are limited to bond price determinants under their direct discretion; agencies can't add value in terms of bond price determinants not under their discretion – refer to Section 2.2: Determinants of Bond Prices. Argue that three separate perspectives exist on these bond price determinants under the direct discretion of rating agencies: a) that of the rating agency itself, b) that of the market, c) the true or perfect perspective that is usually possible in hindsight. Next, argue that, with regards to their perspective, rating agencies have the benefit of Private Information over other market participants.

Hypothetically, four possible cases are thus possible when comparing the perspectives of market participants (rating agencies and the general market) to the perfect perspective. This is shown in Table 6. Note that, generally speaking, the market may only wish to follow the perspective of rating agencies in the second case; whether the market will in turn depends on the market's trust in ratings. The study (findings) of Chan and Jegadeesh (2004) seems to be either a case-2 or a case-4 scenario[55] – if it is a case-2, it seems as if the market trusted in ratings.

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[54] The study of Chan and Jegadeesh (2004) alludes to this assumption, and studies like Altman and Rijken (2006) and Löffler (2003) provide a basis for this assumption.

[55] This is truly a deduction based on (only the obvious) facts at hand. Chan and Jegadeesh (2004) could show positive returns by selling over-rated issues and buying under-rated issues. Over-rated issues were issues their models assigned lower ratings to, compared to the ratings assigned to the issues by a rating agency. Under-rated issues were issues their models assigned higher ratings to, compared to the agency assigned ratings. Without complicating the example by a detailed examination of the underlying finer points and technicalities, the case of positive returns possibly indicates that the market's perspective was not identical to the true perspective. Whether the agencies perspective was identical to the true perspective is a lot harder to say.

Table 6. Perspectives of Market Participants

Case	Market | Perfect	Rating Agencies | Perfect	Market | Rating Agencies
1	=	=	=
2	≠	=	≠
3	=	≠	≠
4	≠	≠	=

Also note what Table 6 implies in terms of Capabilities (competencies) and Perfect Information. It appears as if true Private Information can only exist under case-2, and possibly case-4. With regards to capabilities (competencies) to form opinions on bond price determinants through the use and synthesis of information: the market and agencies have similar capabilities in case-1; the market beats agencies in case-3; agencies either beat or match the market in case-2; case-4 is an open case. Lastly, ratings can only independently impact bond prices in case-2, and possibly case-4 – also the only cases under which Private Information is possible. The ability of ratings to impact bond prices may depend on Capabilities as much Private Information – review case-2 again.

Concluding Remarks

As long as ratings cannot be fully predicted – as long as the determinants of ratings are not fully known - it can't be said that ratings do not contain Private Information, except if the true meaning of Private Information becomes more clear – either through a) a better understanding of the determinants of ratings or b) a better understanding of the factors impacting bond price determinants that are under the direct discretion of rating agencies.[56]

[56] According to Cantor (2004:2567), explaining rating levels is different to predicting rating changes…

(The meaning of) Private Information is dependent on (may evolve with) the determinants of ratings. Better understanding of the determinants of ratings – their proxies and weights (relationship to ratings) – will reveal more about the nature of Private Information – its own proxies and weights. This in essence reflects on *Private Information as seen by Rating Agencies*.

(The meaning of) Private Information is also dependent on (may evolve with) the factors impacting bond price determinants that are under the direct discretion of rating agencies. Private Information may (eventually) require sole access, because the competencies and capabilities of the market to form opinions match that of the agencies; i.e. to beat the competencies and capabilities of the market the agencies rely on sole access. Thus, the competencies and capabilities of the market to form independent opinions can't be ignored.

In illustrating capabilities, take as an example Systematic Risk – as calculated by Elton et al (2001) and delineated under Section 2.2: Determinants of Bond Prices. Without inferring to its relative relevance and weight as a bond price determinant, in the case of Systematic Risk the market are very capable of forming an opinion on their own, and they can put down competencies to do so: Systematic Risk seems to follow a set relationship and thus becomes a clear calculation, similar to the way investors can independently calculate Betas (β) for companies.

Private Information also seems to reflect on the Sole Impact of Ratings - the independent price impact ratings can have on bonds. The meaning of Private Information should make it clear *how* Ratings independently impact bond prices, through (based on) a revelation of its constituents. Importantly, an independent impact on bond prices seems to demand value added to investors (the market) – the value in ratings derive from the assistance ratings offer investors against probable over-pricing or under-pricing at any point.[57]

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[57] Thus, the value that can be added should be proportional to Credit Default Swap (CDS) spreads - refer to Hull et al 2004 for an introduction to CDS. If it is true that, when excluding the CDS spread (premium), issues protected by

With regards to bonds, the value of ratings can be understood by looking at the pricing of bonds: firstly forcing a hypothetical market to price issues without the availing of (access to) ratings, and then introducing ratings as aid during pricing. [At any given time the price of a bond is also the present value of future cash flows…] The value of (added by) ratings cannot be greater than the price-difference resulting from the relative accuracy of pricing under conditions of no rating availability (forced pricing without availing ratings). Put differently, if the market had no access to ratings, how accurately can it still price bonds? The discussion again returns to the competencies and capabilities of the market to form independent opinions…

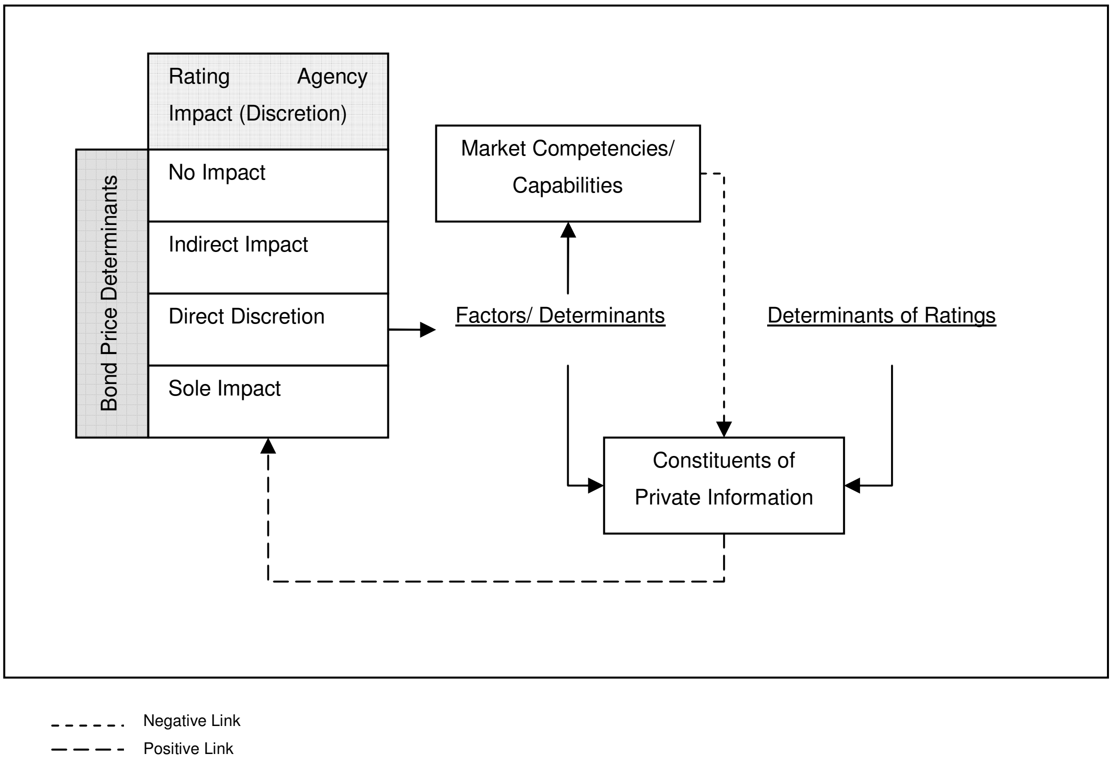

Figure 8. Ratings, Private Information and Bond Price Determinants

Overall, the question of *Independent Impact* seems to revert to the factors impacting bond price determinants agencies have direct discretion over,

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CDS arrangements only have premiums associated with price determinants under indirect (Tax) or no (Liquidity, etc) discretion of ratings, then the maximum value ratings can add is presented by the CDS spread – at least in the case of protection against over-pricing.

versus the determinants of credit ratings. The same point was raised under the conclusion of Section 2.2 - Determinants of Bond Prices.

Remarks under this section are illustrated by Figure 8.[58]

[58] In Figure 8, the direction of the link between *Determinants of Ratings* and *Constituents of Private Information* reflects the current relationship between Ratings and Private Information – the real-world case. Reversing the direction of this particular link provides an illustration of the ideal case: Ratings should probably be determined according to Private Information, which in turn is directed by Factors impacting Direct Discretion Bond Price Determinants and Market Competencies/ Capabilities. The two cases differ: the former captures *ratings as mystery* and wishes to delineate the current constituents of ratings; the latter enquires what ratings should ideally constitute out of…

2.4 Issue-Specific Factors Impacting Bond Price-Reactions to Rating Announcements

A review of the initial work relating bond prices to credit rating changes by Katz (1974); Ingram et al (1983); Hawley and Walker (1992) - and then more recently - the work of Hand et al (1992); Wansley et al (1992); Hite and Warga (1997); and Steiner and Heinke (2001), reveals a number of underlying factors that can possibly explain (cause) differences in the effects credit rating changes have on bond prices. The factors are: a) prior watchlistings; b) major rating changes; c) firms under financial crisis; d) issuer-type and nationality; and e) (differences between) rating agencies themselves. At this stage, the previous two sections of this chapter already make it possible to infer about the relevance of these factors. They are nevertheless briefly reviewed for the sake of consistency.

2.4.1 *Watchlistings*

Steiner and Heinke (2001); Wansley et al (1992) and Hand et al (1992) are examples of studies that have investigated the price-impact of watchlistings independently from the price-impact of actual rating changes.

It is further proposed that the price-impact of actual rating announcements may differ for firms that have been watch-listed prior to the announcement of an actual rating change from firms that have not been watch-listed prior to the rating change (see for instance - Hand et al 1992; Wansley et al 1992).

Before the results of these studies are discussed, the work of Hamilton and Cantor (2004) is briefly reviewed.

Rating Outlooks and Rating Reviews

Hamilton and Cantor (2004) studied the rating transitions of debt issuers rated by Moody's. In their study, Hamilton and Cantor (2004) note - with the aid of specific references - that the serial correlation of credit ratings is well documented. On the topic of serial correlation, they note that, while most issuers’ credit ratings are stable over short time horizons, issues within a given rating cohort have migrated into that cohort from rating categories above and below it. In addition, movement to a new level - or cohort then - often occurs incrementally, rather than with a single multi-notch rating change. These rating changes are typically in the same direction, resulting in positively serially correlated rating changes (rating momentum).

In their study, Hamilton and Cantor (2004) investigate and comment on the serial correlations between,

- the actual ratings themselves
- rating outlooks and actual rating changes/ announcements
- rating reviews (Watchlistings) and actual rating changes/ announcements

The effects of rating history - In their sample, past upgrades were more likely to result in future upgrades than downgrades, whereas the converse is true for past downgrades. The results were not perfectly symmetric however. At both a one-year and three-year time horizon, past rating downgrades were a stronger signal of another rating change in the same direction than were rating upgrades. Furthermore, the effect of past downgrades was relatively stronger for investment-grade-rated issuers than speculative-grade-rated issuers at both a one-and three-year transition horizon.

Hamilton and Cantor (2004) also found strong support for stability of conditional rating transitions - Most issuers retained the rating with which they began the year, regardless of the last rating action. In the aggregate, approximately 70% of issuers' ratings were unchanged over a year on average. At both the one- and three-year horizon, issuers that were upgraded showed the highest level of rating stability; 80% of issuers retained their beginning-of-period rating at the one-year horizon and 46% at the three-year horizon. This result, too, was relatively stronger for investment-grade-rated issuers than speculative-grade-rated issuers.

Actual rating changes versus rating outlooks and rating reviews - According to Hamilton and Cantor (2004), rating outlooks and reviews are designed to anticipate and signal future rating changes.

With regards to outlooks, the authors found that, in their sample, outlooks were indeed systematically associated with future rating actions, at both one- and three-year investment horizons: issues with positive rating outlooks and reviews were much more likely to experience a future credit rating upgrade than downgrade. Conversely, issues with negative outlooks and reviews were highly likely to experience subsequent events of a credit rating downgrade. In essence, outlooks had a very low incidence of false positives; that is, signalling a rating change in the opposite direction. Furthermore, as signals of future rating changes, outlooks were relatively more powerful for investment-grade-rated issuers than speculative-grade-rated issuers.

Also, issuers with stable outlooks exhibited the highest level of rating stability at both a one-and three-year risk horizon. On average 78% of all rated issuers with stable outlooks ended the one-year transition period with the same rating with which they began; that percentage is 53% over three years. Although this result generally holds across all rating categories, it is especially strong for investment-grade-rated issuers. The authors report that, as a signal of rating stability, stable outlooks generally proved to be a more reliable indicator than an unchanged or upgraded rating in the prior year. Over short transition periods (one year), rating upgrades suggested higher rating stability; over three years, however, stable outlooks showed a higher association with no rating change than past rating upgrades and no past rating changes.

With regards to rating reviews, Hamilton and Cantor (2004) found that strong associations existed between Watchlist assignments and rating changes: issues on review for upgrade were nearly twenty-two times more likely on average to be upgraded rather than downgraded. Issues on review for downgrade were thirty-five times more likely to be downgraded than to be upgraded. Even over a three-year holding period, Watchlist assignments continued to exhibit a strong association with rating changes, particularly for reviews for downgrade. Rating reviews were also somewhat stronger signals of future rating change assignments for investment-grade-rated issuers than they were for speculative-grade-rated issuers, with the effect particularly strong for reviews for downgrade.

Bivariate effects of historic rating changes and rating outlooks - As a next step, the authors examined the bivariate effects of historic rating changes and outlooks on future rating actions and came to an important finding: when past rating actions and outlooks were opposite in direction, rating outlooks dominated, indicating that the serial correlation of rating changes are substantially weakened or neutralized once outlook direction was controlled for.

The authors tabulated and showed that, for any given past rating change, credit rating upgrade rates increased with positive conditions, and credit rating downgrade rates also increased with negative conditions. For example, issues with positive outlooks had a 41% likelihood of another upgrade over the next three years, given a credit rating upgrade or no rating change in the last year, and a 48% likelihood of another upgrade; given a credit rating in the last year. Similarly, given a rating upgrade or no rating change within the last twelve months, issues with negative rating outlooks experienced a 55% likelihood of another rating downgrade over the next three years; the three-year likelihood of a downgrade conditional on a downgrade within the last year was 48%.

In summary, the study affirms that rating changes mostly follow single transitions rather than multi-notch steps and that they are normally in the same direction of past ones. In addition, the study notes that outlooks have serial correlations with actual rating announcements; positive outlooks tend to result in a positive rating change more often than a negative rating change.

The converse is also true. The study also comments on the low incidence of false positives associated with rating outlooks; outlooks hardly signal rating actions in the opposite direction. Furthermore, it notes that reviews have strong serial correlations with actual rating announcements. Issues on Watchlist for upgrade were highly likely of an actual upgrade, rather than a downgrade. The converse is also true. Lastly, an important finding of the study is that, when the direction of reviews and past ratings differ, reviews take precedence.

Concluding remarks

Although it is proposed that the price-impact of actual rating announcements may differ for firms that have been watch-listed prior to an actual rating change announcement from firms that have not been watch-listed previously, Hand et al (1992) and Wansley et al (1992) could not find evidence to support this.

To the knowledge of the author, none of the studies to date that relate rating changes to bond prices have discriminated between rating outlooks and rating reviews, or have incorporated rating outlooks – at least none of the studies that were cited in the introductory paragraph to this section. This is understandable - rating outlooks only came into practice in the early 1990s (Hamilton and Cantor 2004). Hull et al (2004) appears to be one of the first to actually investigate all three instances: rating reviews, rating outlooks and rating changes.[59]

The findings of Hamilton and Cantor (2004) indicate that rating reviews are highly probable to end up in a rating change as proposed by the review and therefore may offer little extra information; given the highly probabilistic nature of reviews, one would imagine investors to expect the likelihood that a review

[59] Hull et al (2004) conducted two types of analyses exploring the relationship between the credit default swap market and ratings announcements. The second type of analysis examine ratings announcements conditional on credit spread levels and credit spread changes and is irrelevant to this particular section. In the first type of analysis credit default swap changes conditional on a rating announcement is examined. Hull et al (2004) find that reviews for downgrade contain significant information, but downgrades and negative outlooks do not. There is anticipation of all three types of ratings announcements by the credit default swap market.

will probably end up in the proposed rating direction. Similarly, outlooks with a direction identical to the rating history may offer little new information to investors.

On the other hand, outlooks with direction opposite to the rating history may offer rich information to investors, in that it may signal a possible company and/ or profitability transition or event. It is therefore proposed that a prior watchlisting carries little information or impact, except when an observation's eventual rating change differs in direction than what was proposed by the rating review prior to the rating change; also, outlooks can signal information to the market if the outlook differs in direction than the particular observation's rating history.

Therefore, for both sub-samples of downgrades and upgrades it is expected that the price-impact of a rating change will not significantly differ between observations that have previously been watch-listed and observations that have not previously been watch-listed; except for observations where the direction of the rating review differ from the actual rating event, or observations where the rating outlook signals a turn-around.

2.4.2 *Major Rating Changes*

Movement between investment grade and speculative grade appears to be accompanied by a greater price impact than merely movement within these grades (Hawley and Walker 1992; Wansley et al 1992; Hite and Warga 1997; Steiner and Heinke 2001). Steiner and Heinke (2001) propose the *Price Pressure Hypothesis (Price Pressure due to Institutional Regulation)* to account for the greater abnormal returns (price impact) associated with rating changes that cross across grades.

Steiner and Heinke (2001) further argue the price pressure hypothesis to be a possible explanation for the phenomenon of significant price reactions associated with downgrades, while upgrades do not cause any significant effects. Most institutional investors are prohibited from investing in or holding speculative grade bonds. Announcements of downgrades that cause a bond to cross over from investment grade to speculative grade therefore force institutional bond selling while upgrades do not force buying activities.

Five studies relating rating changes to bond prices are known to have also investigated the effect of a major rating change. These are: Hawley and Walker (1992); Hand et al (1992); Wansley et al (1992); Hite and Warga (1997); Steiner and Heinke (2001). Of the five studies, only three (Hand et al 1992; Wansley et al 1992; Steiner and Heinke 2001) carried out regressions to quantify the effect of a major rating change on the resulting price impact (abnormal returns). What is more, only Steiner and Heinke (2001) found *Investment Grade*, the dummy variable accounting for events that move across investment grades, to be significant; Hand et al (1992) and Wansley et al (1992) did not.

An important difference between the studies of Steiner and Heinke (2001) on the one hand and Hand et al (1992) and Wansley et al (1992) on the other hand is that both Hand et al (1992) and Wansley et al (1992) included a cardinal variable accounting for the absolute rating change together with the *Investment Grade* variable. Both Hand et al (1992) and Wansley et al (1992) rather found the cardinal variable to be significant. The work of Jorion and Zhang (2007) show that the inclusion of such a cardinal variable alongside *Investment Grade* - the dummy variable accounting for events that move across investment grades – may render the *Investment Grade* variable insignificant.

In their study of the impact of rating announcements on stock prices, Jorion and Zhang (2007) found that, by accounting for the role of the rating prior to the announcement, it explained in a large part the puzzling empirical regularity that stock price effects are associated with downgrades, but not upgrades. Also, that it eliminated the investment grade barrier effect that had been reported in previous studies.

Jorion and Zhang (2007) first of all provide theoretical support for different (stock) price effects as a non-linear function of the credit rating prior to the announcement. Their basic argument behind this is that a rating change from, for instance, AA- to A+ carries a smaller change in default risk/ probability than a rating change from BB- to B+ and stock prices ought to reflect this. As theoretical support, Jorion and Zhang (2007) arrive at a relationship between the log of the stock price and the credit rating, by constructing a structural relationship between the stock price and default probability, and by describing a credit rating as an evaluation of creditworthiness – which in their view can be interpreted as the probability of default.[60]

In their empirical tests, cumulative abnormal returns (CAR) were calculated for a sample of stocks with rating events.[61] In the first round, the authors sorted the results based on prior rating - thereby creating sub-samples based on prior rating - and then absolute rating change - rating changes equal to one notch versus rating changes greater than one notch.

In the second round, the authors carried out the same regression on CAR as most prior studies would do - by utilizing a cardinal variable, *Rating Change* – the absolute value of the rating change - and then a dummy variable, *Investment Grade*, to account for observations that cross the investment grade boundary. *Investment Grade* as regression variable was found to be insignificant, whilst *Rating Change* turned out significant. At that stage the regression essentially accounted for the level of the rating change - one of the factors that had been hypothesized to influence stock price effects.

To start accounting for the prior rating, the next step was to include another dummy variable, *Speculative Grade*, in the regression to account for events that moved from speculative grade into investment grade, whilst keeping *Investment Grade* in the regression. Again *Investment Grade* turned out insignificant, whilst *Speculative Grade* and *Rating Change* were significant.

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[60] By using the Merton (1974) model, the authors were able to construct a structural relationship between stock price and default probability. As is known, Merton views the equity of a firm as a call option on the assets of the firm, with an exercise price given by the face value of the debt. The work of Jorion and Zhang (2007) also builds on the fact that default frequencies do not increase monotonically per rating drop.

[61] To do this, the authors utilized the market model to calculate cumulative abnormal returns (CAR) – refer to the Methodology Chapter.

In yet the next step *Speculative Grade* was replaced by *PRT*, a cardinal variable measuring the prior rating. Already the regression model experienced a greater regression coefficient than traditional studies - the authors report a value of 8.38% versus 3.92%. In the final step, the authors included six dummy variables, DM1 – DM6, arranged according to certain sequential groupings of ratings. The logic behind this was that, in order to better account for the logarithmic relationship the theoretical equation pointed out; *DM* must be multiplied by *PRT*. The explanatory power of the regression improved to above 16%, which is a vast improvement from the 3.92% of prior studies.[62]

It is therefore argued that accounting for the prior rating and the level of the rating change will provide a better explanation of the price impact of a rating change across investment grades (instead of within investment grades), than citing the *Price Pressure Hypothesis*. In conclusion, for both sub-samples of downgrades and upgrades, it is expected that, when accounting for the prior rating and the absolute rating change, the impact on the bond price will not significantly differ between observations that cross rating grades during a rating change and observations that stay within their rating grade during a rating change.

2.4.3 *Firms in financial crisis*

It is probable that downgrade-effects may be driven by firms undergoing financial crises. Thus far, only Hite and Warga (1997) explicitly focused on the possibility that firms experiencing financial distress might impact the bond price response to a rating announcement. Whilst Hite and Warga (1997) only went as far back as six months to investigate this possibility, the work of Vassalou and Xing (2004) suggests that it might be more appropriate to take a longer rating-history into consideration – in their study 41.7% of firms that were downgraded, experienced a second downgrade in the subsequent three years after the initial downgrade.

[62] Note how the prior rating is increasingly being accounted for as the study progresses - first “Speculative Grade” as binary dummy variable, then “PRT”, and lastly “PRT*DM”.

Vassalou and Xing (2004) set out to explain the puzzling results of former studies on the effect of rating announcements on stock-prices; former studies would normally report negative abnormal returns associated with downgrades, without any stock-price reaction to upgrades. The authors expected rational investors to require a higher – not lower – return to hold stock of a firm of which the default risk increased, as implied by the downgrade. The authors also felt that the persistence of negative abnormal returns for about three years - as they note had being reported by Dichev and Piotroski (2001) - are even more puzzling.

In measuring default risk, the authors calculated default likelihood indicators (DLI) as an alternative to credit ratings. One of the advantages of this is that DLIs are more frequent than credit ratings: credit ratings are mostly updated on a yearly basis whereas DLIs can be calculated more often – in this case on a monthly basis. They managed DLIs by following the Merton (1974) Model of equity and by using the Black-Scholes (1973) option pricing formula.

By constructing one-month holding portfolios based on DLIs and then calculating abnormal returns for these portfolios, the authors found results in sharp contrast to those of prior literature: increases in default risk (based on DLI-values) were followed by positive abnormal returns, whereas decreases in default risk (based on DLI-values) were followed by abnormal negative returns.

In the next step, the authors plotted DLIs of firms around rating announcements. The result revealed that the DLI of the average firm increased at an increasing rate in the thirty-six months prior to the announcement of a downgrade. It reached its peak at the announcement date and then started decreasing at almost the same rate at which it increased, until it approached almost its twenty-four month pre-downgrade level in about twenty-four months. Thus, the graph of the average DLI had an inverted V-shape, with the peak being placed on the downgrades' announcement date. In their own words:

“The implication of this finding is that when we calculate abnormal returns following a downgrade, it is not sufficient to adjust for the returns of portfolios with comparable size and BM. We also need to make sure that the portfolio whose returns we use to compute the abnormal returns of a firm’s stocks matches the DLI of the firm at each point in time.” (Vassalou and Xing 2004:22)

After this, the authors found that, by taking DLIs into account, abnormal returns associated with downgrades largely disappear - abnormal returns only remained in long horizons. The authors found that they could account for this by excluding firms that were experiencing subsequent downgrades – they found that 41.7% of firms that were downgraded, experience a second downgrade in the subsequent three years after the initial downgrade.

The study of Vassalou and Xing (2004) also shows that a firm’s position in the midst of an upgrade is different to that of a downgrade – the shape of DLIs around upgrades and downgrades differed remarkably. Put differently, from a firm’s perspective, the environment or conditions of an upgrade differs to that of a downgrade.

Coincidentally, in the study of Dallocchio et al (2006), the two firms that report a significant response to a rating action - France Telecom and Vivendi - are also the two firms that experienced the most significant (series of) downgrading during the period of study – five notches for one and seven for the other.

At this point the study by Hamilton and Cantor (2004) is re-introduced. It is clear that rating reviews can signal changes in the health or well-being of a firm, particularly when the direction of the rating review differs from that of the firm’s rating history. It also becomes clear that prior watchlistings and this section - firms under financial crises - are quite related. It has been suggested that Prior watchlistings are informative when they signal a change in the well-being of the issuer.

This section proposes that firms under crises will react differently to rating announcements than more healthy firms. Firms under distress ought to escalate into a trend, whereas more healthy firms ought not to. Unfortunately, some rating history should develop first before the true health of an issuer becomes apparent.

2.4.4 *Issuer-Type and Issuer Nationality*

Issuer Nationality can of course play a role when international bond markets are considered, as was the case in Steiner and Heinke (2001).

Both Wansley et al (1992) and Steiner and Heinke (2001) consider that different issuers (government, financial, corporate, utilities) may be responsible for differences in the price-impact (abnormal returns) of a rating announcement.

"Ho and Michaely (1988) demonstrate that if marginal costs of collecting and processing additional public information exceed its marginal benefit to the investor, market prices will not incorporate all publicly available information. If international investors believe that rating agencies can provide information on international issuers at lower cost, the processed information leading to a rating change or watchlisting can constitute new information to the international market. On this rationale Schweitzer et al (1992) hypothesize that there may be informational differences in the market due to the regulatory environment of some issuers. They argue that banks are closely monitored by regulatory institutions and thus there is more processed credit information available in contrast to non-monitored issuers. If issuing banks in the international market work in a more regulated national environment, the issuer hypothesis states a stronger price move after rating actions compared to non-banks." (Steiner and Heinke 2001:140)

Steiner and Heinke (2001) in fact did generally take into consideration that the business cycle may vary over the period of the study. A possible way to isolate the impact of the business cycle on various issue-types is to utilize reference bonds of the same issue-type – of the same issue-subcategory; Batchelor and Manzoni (2006) is certainly one of the studies that has matched reference bonds with observations under study with the greatest accuracy.

At this point it is proposed that, when accounting for differences in bond prices brought about by the business cycle and the issuer sub-category, no significant difference in the impact on bond prices between observations of different sub-categories or issue types are expected.

2.4.5 *Differences between rating agencies*

Li et al (2004) and Poon and Chan (2008) are both examples of studies that look into the general questions related to rating agencies - whether global agencies are more influential than local agencies and whether even global agencies differ from each other.[63]

Baker and Mansi (2002) examine how bond issuers and investors, the two most important participants in the credit rating industry, assess credit rating agencies. One of the four research questions Baker and Mansi (2002) addressed was whether issuers and institutional investors perceive any differences in the accuracy of ratings among the major rating agencies.

The weights investors place on the results released by different rating agencies may differ; as well as the roles agencies play. Hite and Warga (1997) as well as Steiner and Heinke (2001) investigated this possibility. Both could not find evidence to support this.

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[63] The study of Li et al (2004) relates to the Japanese bond market; the study of Poon and Chan (2008) relates to the Chinese bond market. Both studies relate back to the South African context, given the presence of a local agency amidst global agencies.

3 RESEARCH HYPOTHESIS

3.1 The impact of credit rating changes on bond prices

This study is fundamentally interested in whether credit rating changes significantly impacted bond prices around - mostly on or after - the announcement date of such changes. To a lesser degree, the research is also mindful whether prices had already developed prior to the announcement date; also, the total price development around the rating announcement.

The occurrence of a price movement due to a rating change

A price change in the wake of an actual rating announcement is inevitable, should investors price according to ratings, or rather, should a strong relationship (as opposed to a mild or weak relationship) exist between rating classes and bond prices (i.e. bond prices of similarly rated issues are found to be comparable). The above then also dictates the level of price change to be expected.

Thus - ignoring for a moment whether the methodology is based on abnormal returns or yields, and whether results are kept separate or grouped (summed) - the total price movement in the wake of a rating change is expected to be proportional to the change in yield spread implied by the rating change – i.e. it is dependent on the level of the rating change (pre-rating and post rating). It should be comparable to the difference between ordinary yield spreads associated with the pre-rating and post-rating.

Furthermore, the total price movement *directly attributable to the rating change* should at least exclude bond price determinants ratings have no impact on, but more importantly, bond price determinants ratings only have indirect impact on. Practically, a portion representing tax-premium implications should best be deducted from the total price movement.

The occurrence of a price movement prior to the rating event

The occurrence of a price development prior to the rating event appears to be very likely (rather possible). This is based on the findings of at least Steiner and Heinke (2001).[64] Two points raised by Dynkin et al (2002) were also considered. The points relate to the possibility that the market can anticipate the increasing probability of a rating change, irrespective of whether the issue has been watch-listed or not.

a) Rating agencies typically watch-list an issuer in advance of rating changes, and the fundamental financial information that can trigger a rating action is usually available to market participants well before the downgrade (Dynkin et al 2002:91).

b) Even in cases of no prior watch-listing - disappointing earnings, a large equity buy-back, a planned change in financial leverage, a merger announcement or a rating action are all examples of developments that increase the market's perception of the probability of downgrade (or default) (Dynkin et al 2002).

Under section 2.3, Livingston et al (2003) concluded that it is not surprising that some of the previous studies failed to find evidence that bond ratings had an impact on yields after controlling for public information. The relative high success rates of rating prediction models - and assuming that ratings that are wrongly predicted by rating prediction models generally do not differ substantially (measured in notches) from the assigned rating - generally support the assessment above that investors can pick up an increasing probability of a rating change.

On the other hand the occurrence of price movements prior to the rating change is a lot less likely, should the rating change be extensively grounded/ based on *Private Information*.

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[64] The potential impact – if any - the selected methodology has or has had on the results are ignored for now.

The reason for the rating change, as and if cited by the rating agency is clearly of importance; it becomes an important indication of how much the announcement could unexpectedly impact the bond price (Goh and Ederington 1993).[65] It gives some indication of how substantially the bond price could have developed prior to the announcement.

The points above refer to the relative perspectives of market participants – as delineated under Section 2.3: The Independent Impact of Credit Ratings on Bond Prices, together with the capability of the market to independently assess bond price determinants under the discretion of rating agencies.

The occurrence of a price movement after the rating event

Whether a significant price reaction should be expected after the rating announcement is still an open question. It is in fact the question asked by this study. Such an occurrence is dependent on *Private Information* and its true meaning.

The portion of the price movement that occurs only after the rating announcement that can be directly attributed to the rating change is strongly dependent on the sole impact ratings can have on bond prices, and the indirect impact ratings have on bond prices should again be considered. Put differently, *Private Information* leading to sole impact will likely generate indirect and direct price movements after the rating announcement; tax for one is likely to again cause a second effect. Therefore, only a part of the price movement that occurs after the rating announcement can probably be attributed to the rating change.

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[65] Goh and Ederington (1993) hypothesize that the (equity) market reaction will be conditioned by the reason. If the statement indicates that the rating agency is only responding to public information, little or no market reaction to the announcement is expected. However, if the rating change is based on projections, forecasts, or if there are hints of inside information, then market reaction is anticipated. The rating change explanations in Moody's Bond Survey are grouped into three major categories: a) Actions or decisions that result in a change in the firm's leverage, e.g., leveraged buyouts, debt-financed expansion, etc. b) Improvement or deterioration in the firm's earnings, cash flow, "financial prospects," and/or "performance". c) Miscellaneous or no reason given. The study thus essentially considers two types of rating downgrades: those due to deterioration in the firm's financial prospects and those due to an increase in leverage. It is found that that while the former downgrades reflect Moody's expectations of the firm's future earnings or sales, the latter downgrades are generally in response to past known leverage increases. Consistent with this, a negative equity market reaction to the first group of downgrades but no reaction to the second is observed.

Of all the likely bond price determinants, ratings predominantly have discretion over Default Risk. Thus, the magnitude of the sole impact ratings can possibly have on bond prices more or less relates to the different perspectives of all market participants on Default Risk, whether these perspectives differ, the ability of the market to form an independent opinion on Default Risk based on their competencies, and the ability of rating agencies to complement the independent opinions of the market. Sole impact does not appear to be enormous in magnitude the moment the percentage of bond premiums pertaining to direct impact bond price determinants are isolated and market competencies are actually not assumed to be non-existent.

The impact of different bond attributes

The results may of course differ for certain bond attributes - prior watchlistings; firms experiencing financial crisis as issuer; major rating changes; issuer type and nationality; rating agency are all possible attributes. Nevertheless these differences in attributes are not expected to cause substantial differences in eventual results.

The null- and alternative hypothesis

The null- and alternative hypothesis are:

H_0 : Credit rating announcements have no impact on bond prices

H_1 : Credit rating announcements have an impact on bond prices

It seems as if event studies generally define an impact as a rapid price development in a relatively short period of time. These studies then hope to detect such a rapid price movement just (soon) after the rating announcement date. A definition more suiting to this study might be rather “a change in the projection/ movement of the price”. This is considered in more depth under the Methodology chapter.

4 ON THE COST OF DEFAULT

This section revisits corporate bonds and their pricing. Section 2.2: Determinants of Bond Prices really just looked at past research on the matter, without constructively arguing any of the mentioned studies in real depth. That particular section also mentioned two triangulations: a triangulation between the results of Elton et al (2001), Bennett et al (1994) and Dynkin et al (2002); and then an extension of this triangulation by incorporating Credit Default Swap spreads. This section builds on the default-cost models of Bennett et al (1994) and Elton et al (2001). ***In the end, an alternative modelling of the price of a corporate bond and its cost of default is offered***. Although the outcomes of this section are mostly left to future research, the section sets an important pretence for the Methodology- and subsequent chapters; although the outcomes are not extensively utilized throughout the rest of the study, it is referred to now and again.

Figure 4 under Section 2.2, sourced from the study of Bennett et al (1994), depicts the cost to offset default losses against actual rates or premiums demanded by the market on corporate issues. Although the method of calculation was in fact noted previously, it is quickly revisited as subsequent discussions build on it.

(With regards to Figure 4)… the calculation of additional yields required to offset default losses was based on incremental and cumulative default rates per rating category over a ten year period (1983-1992). The calculation assumes that an investor bought an equal-weighted portfolio of ten-year corporate bonds. The incremental defaults are broken down into semi-annual losses on principal using a 40% recovery rate. Treasury benchmark yields of December 1992 are used to solve the increment of average additional coupon required on the corporate portfolio to offset the default losses and to produce a return identical to the Treasury benchmark yield. The analysis is relative insensitive to Treasury benchmark rates chosen. Actual yield spreads offered were derived from yield statistics on new issues (Bennett et al 1994).

Reinterpreting the calculation of Bennett et al (1994) stipulated above, it is logical to expect the default premium on a risky bond to disappear the moment the cash flows of the bond is secured: if the cash flows are guaranteed, there exists little difference between a corporate bond and a risk-free bond – both offer "secure" cash flow streams. In addition, it can also be taken that "guaranteeing the risky bond" in this case means *to continue promised cash flows so that no difference ever exists between promised cash flows and expected cash flows*, from the vantage point of the investor at least; Bennett et al (1994) offset default losses by means of Treasury benchmarks.

Thus far, mostly two parties were involved – the issuer of the corporate bond and the investor. To complement the discussion, a third entity is introduced: a "fund" contracted by the issuer to guarantee the issue so that investors are at all times convinced that no difference exists between promised cash flows and expected cash flows.[66]

Given its position and function, the fund faces a few questions or uncertainties with regards to fulfilling its role:

a) The expected time (period/ date) of default of the issuer

b) Term Structure Uncertainty/ variation (i.e. risk free rate uncertainty over the period the issue must be guaranteed)

c) The coupon rate of the issue to be guaranteed

d) The probable recovery rate should default occur

e) The fund's ability to refinance default costs

The reasoning behind each is discussed next.

The expected time of default - Argue that, hypothetically speaking, the fund is presently guaranteeing two issues belonging to two different issuers – an

[66] See for instance Duffie and Singleton (1999) and Elton et al (2001) for a more detailed outline of *Promised* and *Expected* cash flows. In this case the "fund" is very synonymous to Credit Default Swaps – refer to Hull et al (2004) for an introduction to the latter.

issue per issuer. Both issues stretch over a ten year period. Issue one is already in period seven; issue two is only in period five. Should both issuers default in the next period, and manage equal recovery rates, the fund will be under obligation to continue more cash flows in the case of issue two and will thus be relatively disadvantaged in terms of issue two, when referenced to issue one.

Term Structure Uncertainty - In this case, argue that the fund has one issue to guarantee. The issue again stretches over a ten year period, and currently finds itself in period three. The fund is without doubt that the issuer will default on the issue in period five. In fulfilling its obligation, the fund therefore needs to carry on with the payment of cash flows to investors from period five to period ten. Alternatively, argue that investors agree to it that the fund may "retire" the issue at default – that is, the fund pays out the present value of all outstanding cash flows to investors at the time of default. The present value of outstanding cash flows at default, which is in period five, will depend on the term structure over period five to period ten. But the fund is not completely certain about the term structure, given that it is only period three.

The greater the uncertainty regarding the future term structure, the greater the risk and thus cost the fund must bear in cases of defaults. If the fund is fortunate, the risk-free rate in the market already contains a premium for term structure uncertainty.[67]

The Coupon Rate – Once more the fund is guaranteeing two issues. The issues differ in terms of their coupon rates, but are identical in time-to-maturity. Should the issues again default at the same time, then the fund will need to continue both issues' cash flows. Assume the fund opts to retire both issues at default by paying investors the present value of all outstanding cash flows at the time of default. The fund will incur greater expenses in the case of the issue with the higher coupon rate than in the case of the issue with the lower coupon rate.

[67] A subsequent sub-section under the Empirical Analysis and Results chapter further looks into *Term Structure Uncertainty*"

The Recovery Rate - The fund is expected to continue promised cash flows, including the par value as a cash flow, but any recoveries at default accrue to the fund. Thus, recoveries should be subtracted from the cost to the fund to continue (secure) promised cash flows. The higher the recovery rate, the lower the cost to the fund.

The fund's ability to refinance – This May be more a practical point than theoretical point; Assume that the fund has many issues it promises to guarantee. The fund therefore needs a certain amount of liquid assets to participate in the daily operation of continuing cash flows. The fund will be heavily burdened should defaults cluster together. But clustering also implies that for extended periods defaults may be infrequent. From the vantage point of the fund it is thus really a case of spreading out default costs the fund will expense/ incur over the long run, in order to reduce the amount of liquid assets required.

Some of these points are really not new, especially *Recovery Rate*. The study rather wishes to further look into the first two points, particularly the first. The first two points were *Expected Time of Default* and *Term Structure Uncertainty*.

Uncertainty regarding the Probable Default Date – the Expected Time of Default

In order to be contracted by an issuer, the fund is expected to quote the necessary rate required to guarantee a particular issue of the issuer. In doing so, the fund should answer itself on the five points listed previously. Most of the points are not that difficult to answer - to come to an agreement on, take Recovery Rate for instance.

In order to quote the issuer, the fund may consult the default-loss models or calculations of Bennett et al (1994), and/ or that of Elton et al (2001). But, with referral to Bennett et al (1994) in particular, the fund is somewhat disadvantaged in that it is not permitted to wait until default to calculate the costs it is likely to endure in guaranteeing the issuer's issue – it is expected to quote on day one and honour the quote; it must forward price the cost of guaranteeing any issuer's issue.

Nevertheless, the fund consults historic data on defaults to guide its costing-decision. The default probabilities of two issues are examined in hindsight. As depicted by Table 7, this is more or less a Boolean case; in hindsight, the issue(r) either did or did not default in the particular period – the question "did the issue(r) default" can be answered by a simple "yes" or "no". It is also quite easy to calculate the cost of default, by simply considering the (present value of the) number of cash flows affected by the default (at the time of default): assuming two coupon payments per period, in the case of issue B of Table 7 it is roughly equal to two coupons times five periods, plus the par value, minus any recoveries.

Table 7. Default Probabilities of two Hypothetical Issues in Hindsight

Period											
P_{n-10}	P_{n-9}	P_{n-8}	P_{n-7}	P_{n-6}	P_{n-5}	P_{n-4}	P_{n-3}	P_{n-2}	P_{n-1}	P_n	
0	0	0	0	0	0	0	0	0	0	0	**Issue A**
0	0	0	0	0	0	1	N/A	N/A	N/A	N/A	**Issue B**

0 = False; 1 = True; N/A = Not Applicable

Unfortunately, in (forward) pricing Issue A and Issue B at period P_{n-10}, the fund can only form an opinion that issue B is likely to default in period P_{n-4}, and a Probability value is probably more appropriate than a Boolean function. In period P_{n-10}, the question "did the issue(r) default in period P_{n-4}" changes to "will the issuer default in Period P_{n-4}". The fund clearly bears an amount of uncertainty regarding a certain period; the uncertainty will also only pass as the period passes - represented by the move from a Probability value to a Boolean case. This is seen as a main critique concerning the calculation of Bennett et al (1994) – in hindsight, a Boolean expression is seen in the place of a Probability value, and with this view a portion of risk premium is not incorporated.

There was no way investors could have known with utmost certainty - as opposed to residual uncertainty - that the bonds in the historic portfolio of Bennett et al (1994) would turn out like they did; at the start of the ten year investment period investors most likely could not draw up a (Boolean) default table for each of the issues in the historic portfolio similar to that shown in Table 7. Therefore, they should have been compensated for bearing residual uncertainty regarding the default date.

Uncertainty regarding the default date surely creates some pricing (default-costing) dilemma. Previously it was mentioned that when the fund asks itself in period P_{n-10} (P_n) whether issue i will default in period P_{n-4} (P_{n+6}), the answer simply cannot be a mere "yes" or "no", but that it will more likely be a "highly likely", "probably", or "highly unlikely". Next, consider hypothetical issue i which stretches over ten periods, as indicated by Table 8. In addition, consider three separate, <u>hypothetical</u> cases where the fund is completely certain that the issue will default in period P_{n+3}, P_{n+6}, and P_{n+9}. Because these are hypothetical cases, the fund can be completely certain about the various time-of-defaults. Furthermore, the result of this compete certainty is that it is possible to move from Probability values to Boolean cases with regards to the default probabilities of periods.

In Table 8, P_i refers to the price of issue i at the beginning of period n, and this is indicated for different periods and under the different cases. Similarly, DP_i refers to the default probability of issue i, for different periods and under the different cases. CF_k refers to cash flows to be received at the end of period n. In the figure, the par-value is seen as included in the last coupon and is thus not indicated separately. The cases are really elementary and consider a recovery rate of 100%. More complex cases can of course be developed to take lower recovery rates into consideration, but this is not crucial to the point.

Table 8. The Impact of Time of Default on bond pricing

Period » (↓) Issue i		P_n	P_{n+1}	P_{n+2}	P_{n+3}	P_{n+4}	P_{n+5}	P_{n+6}	P_{n+7}	P_{n+8}	P_{n+9}	P_{n+10}
Cash Flows		CF_k	CF_{k+1}	CF_{k+2}	CF_{k+3}	CF_{k+4}	CF_{k+5}	CF_{k+6}	CF_{k+7}	CF_{k+8}	CF_{k+9}	CF_{k+10}
Case A	DP_{iA}	$DP_{iA(n)}$	$DP_{iA(n+1)}$	$DP_{iA(n+2)}$	$DP_{iA(n+3)}$	$DP_{iA(n+4)}$	$DP_{iA(n+5)}$	$DP_{iA(n+6)}$	$DP_{iA(n+7)}$	$DP_{iA(n+8)}$	$DP_{iA(n+9)}$	$DP_{iA(n+10)}$
		0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	P_{iA}	$P_{iA(n)}$	$P_{iA(n+1)}$	$P_{iA(n+2)}$	$P_{iA(n+3)}$	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		$P_{iA(n)} = \sum_{k=n}^{n+3} PV(CF_k)$; $P_{iA(n+1)} = \sum_{k=(n+1)}^{n+3} PV(CF_k)$; $P_{iA(n+2)} = \sum_{k=(n+2)}^{n+3} PV(CF_k)$;...										
Case B	DP_{iB}	$DP_{iB(n)}$	$DP_{iB(n+1)}$	$DP_{iB(n+2)}$	$DP_{iB(n+3)}$	$DP_{iB(n+4)}$	$DP_{iB(n+5)}$	$DP_{iB(n+6)}$	$DP_{iB(n+7)}$	$DP_{iB(n+8)}$	$DP_{iB(n+9)}$	$DP_{iB(n+10)}$
		0	0	0	0	0	0	1	N/A	N/A	N/A	N/A
	P_{iB}	$P_{iB(n)}$	$P_{iB(n+1)}$	$P_{iB(n+2)}$	$P_{iB(n+3)}$	$P_{iB(n+4)}$	$P_{iB(n+5)}$	$P_{iB(n+6)}$	N/A	N/A	N/A	N/A
		$P_{iB(n)} = \sum_{k=n}^{n+6} PV(CF_k)$; $P_{iB(n+1)} = \sum_{k=(n+1)}^{n+6} PV(CF_k)$; $P_{iB(n+2)} = \sum_{k=(n+2)}^{n+6} PV(CF_k)$;...										
Case C	DP_{iC}	$DP_{iC(n)}$	$DP_{iC(n+1)}$	$DP_{iC(n+2)}$	$DP_{iC(n+3)}$	$DP_{iC(n+4)}$	$DP_{iC(n+5)}$	$DP_{iC(n+6)}$	$DP_{iC(n+7)}$	$DP_{iC(n+8)}$	$DP_{iC(n+9)}$	$DP_{iC(n+10)}$
		0	0	0	0	0	0	0	0	0	1	N/A
	P_{iC}	$P_{iC(n)}$	$P_{iC(n+1)}$	$P_{iC(n+2)}$	$P_{iC(n+3)}$	$P_{iC(n+4)}$	$P_{iC(n+5)}$	$P_{iC(n+6)}$	$P_{iC(n+7)}$	$P_{iC(n+8)}$	$P_{iC(n+9)}$	N/A
		$P_{iC(n)} = \sum_{k=n}^{n+9} PV(CF_k)$; $P_{iC(n+1)} = \sum_{k=(n+1)}^{n+9} PV(CF_k)$; $P_{iC(n+2)} = \sum_{k=(n+2)}^{n+9} PV(CF_k)$; ...										

0 = False; 1 = True; N/A = Not Applicable

When referencing Table 8, pay particular attention to how the default date affects the price of the issue. Should it be certain that the issue will default in three periods time - as in case A - only the present value of the following three periods should be included; the same applies in the cases where it is know that the issue will surely default in six periods (case B) and nine periods (case C).

Nevertheless, in a previous paragraph it was clearly stated that utmost certainty regarding the default date is not possible. Therefore in moving from the hypothetical case to a more realistic case, the default probabilities pertaining to specific periods should rather be changed from Boolean cases to Probability values.

Thus, under risk-neutral conditions the price at time t of issue i, which is currently in period n (take $n=1$) with m periods to maturity can be written as:

$$\begin{aligned}P_{it} &= [DP_{in}.\sum_{k=n}^{n} PV(CF_{ik})] + [DP_{i(n+1)}.\sum_{k=n}^{n+1} PV(CF_{ik})] + [DP_{i(n+2)}.\sum_{k=n}^{n+2} PV(CF_{ik})] + ... \\ &+ [DP_{i(n+m-1)}.\sum_{k=n}^{n+m-1} PV(CF_{ik})] + [DP_{i(n+m)}.\sum_{k=n}^{n+m} PV(CF_{ik})]\end{aligned} \qquad \textbf{[5]}$$

Note that Equation [5] requires an array of periodic default probabilities $DP_{i(n;m)}$, and that this array probably moves with time; when moving from period P_n to P_{n+1}, and so forth, the values of the array of default probabilities probably do not remain the same. In addition, if these default probabilities are understated, it will result in an over-valued price at the present time (t) and this in turn will result in capital losses. At present, Equation [5] does not correctly consider the case that issue i may in fact not default at all. This is corrected in Equation [6].

$$\begin{aligned}P_{it} &= [DP_{in}.\sum_{k=n}^{n} PV(CF_{ik})] + [DP_{i(n+1)}.\sum_{k=t}^{n+1} PV(CF_{ik})] + [DP_{i(n+2)}.\sum_{k=t}^{n+2} PV(CF_{ik})] + ... \\ &+ [DP_{i(n+m-1)}.\sum_{k=n}^{n+m-1} PV(CF_{ik})] + [DP_{i(n+m)}.\sum_{k=n}^{n+m} PV(CF_{ik})] + [(1-\sum_{j=n}^{n+m} DP_{ij}).\sum_{k=n}^{n+m} PV(CF_{ik})]\end{aligned} \qquad \textbf{[6a]}$$

In Equation [6b], Equation [6a] is rewritten to better account for actual recoveries of par $R_{i(n;m)}$ - the issue's par-value multiplied by the respective recovery rate. Although the equation specifies periodic recovery rates, this study does not wish to purport that the rates can't be equal for all periods. In Equation [6a] the CF_{ik} terms refer to cash flows, and in Equation [6b] the C_{ik}

terms refer to coupons. Equation [6a] includes the par-value with the last coupon as cash flow and assumes Recovery Rates equal to 100%.

$$
\begin{aligned}
P_{it} &= DP_{in}[PV(Par.R_{in})] + DP_{i(n+1)}[(\sum_{k=n}^{n} PV(C_{ik})) + PV(Par.R_{i(n+1)})] \\
&+ DP_{i(n+2)}[(\sum_{k=n}^{n+1} PV(C_{ik})) + PV(Par.R_{i(n+2)})] + \ldots \\
&+ DP_{i(n+m-1)}[((\sum_{k=n}^{n+m-2} PV(C_{ik})) + PV(Par.R_{i(n+m-1)})] \\
&+ DP_{i(n+m)}[(\sum_{k=n}^{n+m-1} PV(C_{ik})) + PV(Par.R_{i(n+m)})] \\
&+ (1 - \sum_{j=n}^{n+m} DP_{ij})[(\sum_{k=n}^{n+m} PV(C_{ik})) + PV(Par)]
\end{aligned}
\qquad \textbf{[6b]}
$$

Next, Equation [6] is extended by making use of risk-free spot rates ($e^{-r(t)}$). In the equation, L refers to the length of a period, and u to the remaining fraction-length of the current period $(u \leq L)$.[68]

$$
\begin{aligned}
P_{it} &= DP_{in}[(Par.R_{in})e^{-(u).r_{tu}^{G}}] \\
&+ DP_{i(n+1)}[(\sum_{k=n}^{n} C_{ik}.e^{-((k-1)L+u).r_{(t;(k-1)L+u)}^{G}}) + (Par.R_{i(n+1)})e^{-((n)L+u).r_{t;(n)L+u}^{G}}] \\
&+ DP_{i(n+2)}[(\sum_{k=n}^{n+1} C_{ik}.e^{-((k-1)L+u).r_{t;(k-1)L+u}^{G}}) + (Par.R_{i(n+2)})e^{-((n+1)L+u).r_{t;(n+1)L+u}^{G}}] + \ldots \\
&+ DP_{i(n+m-1)}[(\sum_{k=n}^{n+m-2} C_{ik}.e^{-((k-1)L+u).r_{t;(k-1)L+u}^{G}}) + (Par.R_{i(n+m-1)})e^{-((n+m-2)L+u).r_{t;(n+m-2)L+u}^{G}}] \\
&+ DP_{i(n+m)}[(\sum_{k=n}^{n+m-1} C_{ik}.e^{-((k-1)L+u).r_{t;(k-1)L+u}^{G}}) + (Par.R_{i(n+m)})e^{-((n+m-1)L+u).r_{t;(n+m-1)L+u}^{G}}] \\
&+ (1 - \sum_{j=n}^{n+m} DP_{ij})[(\sum_{k=n}^{n+m} C_{ik}.e^{-((k-1)L+u).r_{t;(k-1)L+u}^{G}}) + (Par)e^{-((n+m-1)L+u).r_{t;(n+m-1)L+u}^{G}}] \\
&= \sum_{k=n}^{n+m} C_{ik}.e^{-((k-1)L+u).r_{t;(k-1)L+u}^{G}} (\sum_{j=n+1}^{n+m} DP_{ij} + P_{no\_default}) \\
&+ Par(P_{no\_default}.e^{-((n+m-1)L+u.r_{t;(n+m-1)L+u}^{G}} + \sum_{j=n}^{n+m} DP\;R\;.e^{-((j-1)L+u).r_{t;(j-1)L+u}^{G}})
\end{aligned}
$$

$$
P_1 + P_2 + P_3 + P_4 + P_5 + P_{no\_default} = 1 \qquad \textbf{[6c]}
$$

[68] The units of L and u should correspond with that of the spot rates used; the spot rates will very likely be annualized rates.

$$
\begin{aligned}
P_{it} &= C_1(P_2 + P_3 + P_4 + P_5 + P_{no\_default}) \\
&\quad + C_2(P_3 + P_4 + P_5 + P_{no\_default}) \\
&\quad + C_3(P_4 + P_5 + P_{no\_default}) \\
&\quad + C_4(P_5 + P_{no\_default}) \\
&\quad + C_5(P_{no\_default}) \\
&\quad + Par(R_1P_1 + R_2P_2 + R_3P_3 + R_4P_4 + R_5P_5 + P_{no\_default})
\end{aligned} \quad \textbf{[7]}
$$

Equation [6] requires the various $DP_{i(n;m)}$ terms to be such that the model always satisfies the following general condition: the modelled price P_{it} can never be greater than the present value of the sum of outstanding, promised cash flows of issue i at time t. Below, Equation [6] is written out for a five period bond, assuming a risk free rate of zero over the five periods. For simplicity, assume: $R_1 \approx R_2 \approx R_3 \approx R_4 \approx R_5$. The condition seems to be met – only when $P_{no\_default}$ is equal to one will Equation [7] equal the sum of the cash flows.

The Default Risk Model of Elton et al (2001)

Equation [6] differs from the default cost calculation of Elton et al (2001:274). In calculating/ modelling default losses, Elton et al (2001) argue the case of a two period bond with Par-value equal to currency-1, and its value at period 0 and period 1 – see Equations [8] to [11]. In these equations, P_t is the probability of bankruptcy in period t; C is the coupon rate; and a is the recovery rate. Also, V_{tT} is the value of a T period bond in period t; r_{tt+1}^{G} is the forward rate as of time 0, from period t to $t+1$ on risk free bonds; and r_{tt+1}^{C} s the forward rate as of time 0, from period t to $t+1$ on corporate bonds.

In deriving the equations, Elton et al (2001) switch back and forth between discounting expected cash flows at the risk-free rate, and discounting promised cash flows at the appropriate corporate risk rate.

$$V_{12} = [C(1-P_2) + aP_2 + (1-P_2)]e^{-r_{12}^{G}} \quad \textbf{[8]}$$

$$V_{12} = (C+1)e^{-r_{12}^{C}} \quad \textbf{[9]}$$

$$V_{02} = [C(1-P_1) + aP_1 + (1-P_1)V_{12}]e^{-r_{01}^{G}} \quad \textbf{[10]}$$

$$V_{02} = (C+V_{12})e^{-r_{01}^{C}} \quad \textbf{[11]}$$

With these equations, Elton et al (2001) can thus write the difference between the corporate rate and risk-free rate as:

$$e^{-(r_{01}^{C} - r_{01}^{G})} = (1-P_1) + \frac{aP_1}{V_{12}+C} \quad \textbf{[12]}$$

…or,

$$e^{-(r_{tt+1}^{C} - r_{tt+1}^{G})} = (1-P_{t+1}) + \frac{aP_{t+1}}{V_{t+1T}+C} \quad \textbf{[13]}$$

When unpacking the V_{12} term – or rather the V_{t+1T} term then – in Equation [12] ([13]) it seems as if there is little difference between Equation [12] ([13]) of Elton et al (2001) and Equation [5] of this study. What is more, Elton et al (2001) do in fact consider an array of default probabilities to some extent, through their use of marginal default probabilities. Marginal default probabilities are developed from a transition matrix employing the assumption that the transition process is stationary and Markovian.

An examination reveals that any difference between Equation [13] and Equation [6] stems from Equation [10]. Rewriting Equation [10] according to Equation [6] in the case of a two-period bond with Par-value equal to currency-1 gives:

$$\begin{aligned} V_{02} &= (aP_1 + CP_2 + CP_{no\_default})e^{-r_{01}^{G}}(aP_2 + CP_{no\_default} + P_{no\_default})e^{-r_{02}^{G}} \\ &= [aP_1 + CP_2 + C(1-P_1-P_2)]e^{-r_{01}^{G}} + [aP_2 + C(1-P_1-P_2) + (1-P_1-P_2)]e^{-r_{02}^{G}} \end{aligned} \quad \textbf{[14]}$$

The difference between Equation [10] and Equation [14] is equal to:

$$\Delta V_{02} = -P_1 P_2 (C + 1 - a) e^{-r_{02}^G} \qquad \textbf{[15]}$$

The resultant difference in Equation [13] brought about by Equation [14] is:

$$\Delta\left(e^{-(r_{01}^C - r_{01}^G)} \right) = \frac{P_1 V_{12}}{C + V_{12}} - [\frac{P_1 (C+1)}{C + V_{12}}] e^{-r_{12}^G} \qquad \textbf{[16]}$$

In arriving at the equations, it was necessary to assume that P_2 remains the same in the two consecutive periods:

$$P_{no\_default}^{02} = 1 - P_1 - P_2^{02}$$
$$P_{no\_default}^{12} = 1 - P_2^{12}$$
$$P_2^{02} = P_2^{12} \qquad \textbf{[17]}$$

All calculations are shown under APPENDIX I. Thus, it appears that Elton et al (2001) captures the value of a bond differently than does Equation [6], seemingly due to a different point of view on periodic default probabilities. It seems as if Elton et al (2001) base their default probability values on backwards calculated values and focus on mostly one period, whereas Equation [6] demands a forward perspective over the lifetime of the bond; Equation [6] seems more sensitive to the fact that the present value (price) of a bond is very dependent on the actual default date.

Put differently, Elton et al (2001) considers probabilities conditional on arriving at a (making it to/ surviving until a) period in the bond's life, whereas Equation [6] considers that the present value of a bond is impacted (deflated) by the important fact that the issue can possibly default in any period of its lifetime – the present value of the issue is impacted by periodic default probabilities over its entire lifetime.

The difference between the two models (Equation [6] and Equation [13]) will be further aggravated by longer period bonds than the two-period bond considered by Elton et al (2001) in deriving Equation [13]. The Equations of Elton et al (2001) may also experience difficulty when attempting a price forecast - as opposed to applying the model in hindsight - due to uncertainty in the V_{t+1T} term. In hindsight historic price data is used. Forward looking, it is impossible to state the V_{t+1T} term in Equation [13] with complete certainty; rather than purporting that the V_{t+1T} term will be equal to x, realistically anything between x and y may be possible.

Three key points emerge from the comparison thus far:

a) Subsequent periodic default probabilities are likely non-zero, because the probability that an issue will not default during its lifetime is likely non-zero

b) Any variation in the default probabilities of subsequent periods probably has price impacts

c) It appears as if the first period default probability (DP_n - see Equation [12]) impacts as much on subsequent periodic default probabilities ($\sum_{j=n+1}^{n+m} DP_j$ -see Equation [13]), as these impact on the first period default probability

Non-zero subsequent periodic default probabilities

If it is true that at the end of period t, a m period issue's probability to actually default in its lifetime - as opposed to never defaulting - is correctly captured by Equation [18], then $P_{no\_default}$ must be equal to one if $P_{default}$ is equal to zero.

$$P_{no\_default} = (1 - P_{default}) = (1 - (\sum_{j=n}^{n+m} DP_j)) \qquad \textbf{[18]}$$

$$DP_n = (1 - (\sum_{j=n+1}^{n+m} DP_j) - P_{no\_default}) \qquad \textbf{[19]}$$

It can however be questioned whether the market will concur that, for any bond, $P_{no\_default}$ can be equal to one; if a bond has the probability to be downgraded – and all bonds do, even some of the highest rated bonds have been downgraded before - it has a non-zero probability of default, regardless of how small this probability may be.[69] Given that $P_{no\_default}$ is probably not equal to one it means that $\sum_{j=n+1}^{n+m} DP_j$ is then also non-zero, regardless whether DP_n is equal to zero or not. Non-zero subsequent default probabilities are closely related to downgrade risk. Also, non-zero subsequent default probabilities have a clear price impact – see Equation [6].

The price impact of Variation in subsequent periodic default probabilities

Equation [16] actually contains a risk-free spot rate term…

Refer to Equation [6] – any resultant price movement when moving from one period to another is due to:

a) Variation in the risk-free term structure

b) Variation in subsequent default probabilities

c) The first period default probability - DP_n

For simplicity, assume that the term-structure remains constant for the remainder of the lifetime of issue i. Thus, no change in price is brought on by the term structure when moving from period P_n to period P_{n+1}. Next, assume that the remaining subsequent probabilities also remain constant when moving from period P_n to period P_{n+1}. Therefore, any change in price when moving from period P_n to period P_{n+1} is due to the maturity of DP_n – DP_n falls away and DP_{n+1} essentially becomes DP_n. Now, relax the above two assumptions.

[69] Also, think back to Event Risk and its rather random nature, as was outlined under Section 2.2: Determinants of Bond Prices.

In case C of Table 8, $DP_{i(n+5)}$ for instance affects issue i in both periods P_n and P_{n+1}, but it is likely that $DP_{i(n+5)}$ will be exactly the same in (for) both periods ($DP_{i(n+5)} | P_n \neq DP_{i(n+5)} | P_{n+1}$)?

Both points b) and c) may help to explain movements in any corporate term structure…

The impact of the first period default probability on subsequent periodic default probabilities

In Equation [16], a lot more terms representing subsequent periodic default probabilities were expected; instead DP_n turned up quite a number of times.

In calculation default losses, Elton et al (2001) does so for a period, i.e. the calculation is period-specific. One should ask the question whether any "losses" - or similar constructs resulting in losses - emanating from subsequent periods (with regards to the period the default losses are calculated for) are not in fact dispensable in the first period already - the period the default loss calculation/ rate is computed for. If this is the case, it would result in a higher default-loss rate in the first period. Thus, if the bond-price adjusts because the default probabilities of subsequent sections adjust - not in their respective periods, but rather from the first period already - investors are carrying a part of the risk associated with variation in default probabilities of subsequent sections in the first period already.

In addition, consider the following. Argue that the periodic default probabilities can be calculated at any given time – as opposed to being completely unknown - based on a certain number of underlying factors and their values; by noting (following) a number of factors it is possible to derive periodic default probability values. This is done at the beginning of period P_n to derive DP_n and the other subsequent periodic default probability terms - DP_{n+1} to DP_{n+m}. The process is repeated at the beginning of period P_{n+1} - the factors are again interpreted to update DP_{n+1} to DP_{n+m}. It is not difficult to belief that at the beginning of P_n, the value of DP_n is dependent on how DP_{n-1} realized (it will reflect in the values of the underlying factors) - and at the beginning of P_{n+1} DP_{n+1} to DP_{n+m} is dependent on how DP_n realized.

In essence, the paragraphs above are referring to both risk-free term structure variation, and corporate term-structure variation. The market risk-free rates may or may not already contain a risk-free term structure variation premium; this is not known.

The Cost of Default

At this point, by selecting default probabilities for the number of periods involved, it is possible to calculate the price of a bond - and the cost of default - for a particular time in an issue's life, prior to its maturity. Cost of Default should equal the present value of all outstanding, promised cash-flows at the time of default, minus the present value of any recoveries. Compare Equation [6] with Equation [20]. Cost of Default of issue i at time t is also equal to the present value of all outstanding cash flows of issue i at time t, minus the price of the issue i at time t. This is shown in Equation [21].

$$
\begin{aligned}
CoD_{it} &= \sum_{j=n}^{n+m} PV(DP_{ij}.CoD_{ij}) \\
&= \sum_{j=n}^{n+m} PV_t(DP_{ij}.[\sum_{k=j}^{n+m} PV_j(C_{ik}) + PV_j(Par) - Par.R_{ij}]) \\
&= \sum_{j=n}^{n+m} DP_{ij}[e^{-((j-1)L+u).r^G_{t;(j-1)L+u}}((\sum_{k=j}^{n+m} C_{ik}.e^{-((k-j)L).r^G_{(j-1)L+u;(k-1)L+u}}) \\
&\quad + (Par.e^{-((n+m-j)L).r^G_{(j-1)L+u;(n+m-1)L+u}} - Par.R_{ij})] \\
&= \sum_{j=n}^{n+m} DP_{ij}[(\sum_{k=j}^{n+m} C_{ik}.e^{-((k-1)L+u).r^G_{t;(k-1)L+u}}) \\
&\quad + (Par.e^{-((n+m-1)L+u).r^G_{t;(n+m-1)L+u}} - Par.R_{ij}.e^{-((j-1)L+u).r^G_{t;(j-1)L+u}})] \\
&= \sum_{k=n}^{n+m} C_{ik} e^{-((k-1)L+u).r^G_{t;(k-1)L+u}} (\sum_{j=n}^{k} DP_{ij}) \\
&\quad + Par[(\sum_{j=n}^{n+m} DP_{ij} e^{-((n+m-1)L+u).r^G_{t;(n+m-1)L+u}}) - (\sum_{j=n}^{n+m} DP_{ij}.R_{ij} e^{-((j-1)L+u).r^G_{t;(j-1)L+u}})]
\end{aligned}
$$

$$
\sum_{j=n}^{n+m} DP_{ij} = 1 - P_{no\_default} \qquad \textbf{[20]}
$$

The premium required to compensate for the likelihood of default should thus be the rate required to set the calculated price of the bond equal to the present value of the outstanding, promised cash flows. Bennett et al (1994) calculate an average additional coupon required to offset default losses. Similarly, Equation [22] incorporates an additional (continuous compounded) effective annual discount rate on the coupon cash flows to negate default losses, based on the Cost of Default. In the Equation, the price of the issue is based on Equation [6].

$$
\begin{aligned}
& CoD_{it} + P_{it} = \\
& \quad \sum_{k=n}^{n+m} C_{ik} e^{-((k-1)L+u).r^G_{t;(k-1)L+u}} \left(\sum_{j=t}^{k} DP_{ij}\right) \\
& \quad + Par[(\sum_{j=n}^{n+m} (DP_{ij} e^{-((n+m-1)L+u).r^G_{t;(n+m-1)L+u}}) - (\sum_{j=n}^{n+m} DP_{ij}.R_{ij} e^{-((j-1)L+u).r^G_{t;(j-1)L+u}})] \\
& \quad + \sum_{k=n}^{n+m} C_k e^{-((k-1)L+u).r^G_{t;(k-1)L+u}}.(P_{no\_default} + \sum_{j=k+1}^{n+m} DP_{ij}) \\
& \quad + Par[(\sum_{o=n}^{n+m} DP_{io}.R_{io}.e^{-((o-1)L+u).r^G_{t;(o-1)L+u}}) + (P_{no\_default}.e^{-((n+m-1)L+u).r^G_{t;(n+m-1)L+u}})] \\
& \quad = \sum_{k=n}^{n+m} C_{ik} e^{-((k-1)L+u).r^G_{t;(k-1)L+u}} (P_{no\_default} + \sum_{j=n}^{k} DP_{ij} + \sum_{j=k+1}^{n+m} DP_{ij}) \\
& \quad + Par[-(\sum_{j=n}^{n+m} DP_{ij}.R_{ij} e^{-((j-1))L+u).r^G_{t;(j-1)L+u}}) + (\sum_{o=n}^{n+m} DP_{io}.R_{io}.e^{-((o-1)L+u).r^G_{t;(o-1)L+u}})] \\
& \quad + Par[(P_{no\_default}.e^{-((n+m-1)L+u).r^G_{t;(n+m-1)L+u}}) + (\sum_{j=n}^{n+m} (DP_{ij} e^{-((n+m-1)L+u).r^G_{t;(n+m-1)L+u}})] \\
& \quad = \sum_{k=n}^{n+m} C_k.e^{-((k-1)L+u).r^G_{t;(k-1)L+u}} + Par.e^{-((n+m-1)L+u).r^G_{t;(n+m-1)L+u}} \\
& \quad = PV(issue_i)
\end{aligned}
\qquad \textbf{[21]}
$$

$$
\begin{aligned}
& PV(issue_i) = P_{it} + CoD_{it} \\
& PV(issue_i) = \sum_{k=n}^{n+m} C_k.e^{-((k-1)L+u).r^G_{t;(k-1)L+u}} + Par.e^{-((n+m-1)L+u).r^G_{t;(n+m-1)L+u}} \\
& \qquad P_{it} = \sum_{k=n}^{n+m} C_k.e^{-((k-1)L+u).r^G_{t;(k-1)L+u}}.e^{-((k-1)L+u).r_i^{CoD}} + Par.e^{-r^G_{t;(n+m-1)L+u}}
\end{aligned}
\qquad \textbf{[22]}
$$

The relative ability of the market to diversify through the utility of portfolios is clearly an important point; although the first period default probability is normally low, the bond value ought to move tremendously in the event that it does come true, realizing huge capital losses. The effect can be visualized through a frequency plot of the bond value for the particular point in time.[70]

Also, should default occur in the first period, then the actual cost of default will be greater than the default risk premium demanded on the bond - even if the first period default probability is low - because the premium is an average rate spread over the lifetime of the bond.[71]

Nevertheless, the risk of resultant huge capital losses can be mitigated through portfolios. With a portfolio, periodic default probabilities are based on the underlying periodic default probabilities of its members[72]; the average default probability of the portfolio in the first period should also be small. Therefore, based on the average first period default probability of the portfolio, even if one or two members (issues) belonging to the portfolio defaults within the first period, the resultant capital losses are mitigated by the sum of the contributions of other members, resulting from their non-zero default risk premiums.[73] Thus, a relationship exists between the (required) number of members of a portfolio and the portfolio's average first period default probability (see also Dynkin et al 2002). The fund requires enough members to offset the ramifications of average capital losses (average default cost) pertaining to its average first period default probability.

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[70] In essence, plot two prices for issue i at the end of period n by setting DP_{in} in Equation [6] equal to zero and then equal to one.

[71] Again plot two costs – the Cost of Default - for issue i by setting DP_{in} in Equation [21] equal to zero and then equal to one. Also, use Equation [22] and compare the average rate required under each scenario. Equation [22] is dependent on the price of the bond, which will significantly differ for DP_{in} equal to zero and DP_{in} equal to one.

[72] As an illustration – take as many dices as there are portfolio members. For simplicity, assume that a) all members have equal periodic default probabilities, b) that all periods have the same default probabilities, and c) that default probabilities are equal to one over eight – the number of sides a dice has; should any dice land on "one", then it represents the case of default. Generally, the lower the number of members that default in the first period, the better it is for the fund. To see how many of the portfolio members will default in the first period through all the dices and count the number of dices that landed on "one". Increase the number of sides (that some of) the dices have to better represent actual market circumstances. Interestingly, the probability that all members belonging to a fund will default within the first period should be very small (decrease with an increase in members), albeit the occurrence is never impossible. [If x members of a market portfolio defaulting in the first period implies *financial crisis*, it is even possible to calculate the probability of a financial crisis.]

[73] Calculate and compare the cost of default and the resultant rate on a portfolio with that of an individual bond.

Concluding Remarks

In offering a more practical example of the above discussion, it is returned to the vantage point of the fund wishing to guarantee a number of corporate issues. In quoting premiums to guarantee issues, the fund is probably best off by specifying a number of default probabilities – one for each period over the bond's life. This is illustrated by Table 9 for a number of issues, with different maturities (ten years; eight years; nine years).

Table 9. The Utility of Default Probabilities

Period	Issue A		Issue B		Issue C		Fund	
P_n	DP_{An}	CoD_{An}	DP_{Bn}	CoD_{Bn}	DP_{Cn}	CoD_{Cn}	DP_{Fn}	CoD_{Fn}
P_{n+1}	$DP_{A(n+1)}$	$CoD_{A(n+1)}$	$DP_{B(n+1)}$	$CoD_{B(n+1)}$	$DP_{C(n+1)}$	$CoD_{C(n+1)}$	$DP_{F(n+1)}$	$CoD_{F(n+1)}$
P_{n+2}	$DP_{A(n+2)}$	$CoD_{A(n+2)}$	$DP_{B(n+2)}$	$CoD_{B(n+2)}$	$DP_{C(n+2)}$	$CoD_{C(n+2)}$	$DP_{F(n+2)}$	$CoD_{F(n+2)}$
P_{n+3}	$DP_{A(n+3)}$	$CoD_{A(n+3)}$	$DP_{B(n+3)}$	$CoD_{B(n+3)}$	$DP_{C(n+3)}$	$CoD_{C(n+3)}$	$DP_{F(n+3)}$	$CoD_{F(n+3)}$
P_{n+4}	$DP_{A(n+4)}$	$CoD_{A(n+4)}$	$DP_{B(n+4)}$	$CoD_{B(n+4)}$	$DP_{C(n+4)}$	$CoD_{C(n+4)}$	$DP_{F(n+4)}$	$CoD_{F(n+4)}$
P_{n+5}	$DP_{A(n+5)}$	$CoD_{A(n+5)}$	$DP_{B(n+5)}$	$CoD_{B(n+5)}$	$DP_{C(n+5)}$	$CoD_{C(n+5)}$	$DP_{F(n+5)}$	$CoD_{F(n+5)}$
P_{n+6}	$DP_{A(n+6)}$	$CoD_{A(n+6)}$	$DP_{B(n+6)}$	$CoD_{B(n+6)}$	$DP_{C(n+6)}$	$CoD_{C(n+6)}$	$DP_{F(n+6)}$	$CoD_{F(n+6)}$
P_{n+7}	$DP_{A(n+7)}$	$CoD_{A(n+7)}$	$DP_{B(n+7)}$	$CoD_{B(n+7)}$	$DP_{C(n+7)}$	$CoD_{C(n+7)}$	$DP_{F(n+7)}$	$CoD_{F(n+7)}$
P_{n+8}	$DP_{A(n+8)}$	$CoD_{A(n+8)}$	-	-	$DP_{C(n+8)}$	$CoD_{C(n+8)}$	$DP_{F(n+8)}$	$CoD_{F(n+8)}$
P_{n+9}	$DP_{A(n+9)}$	$CoD_{A(n+9)}$	-	-	$DP_{C(n+9)}$	$CoD_{C(n+9)}$	$DP_{F(n+9)}$	$CoD_{F(n+9)}$
P_{n+10}	DP^A_{n+10}	CoD^A_{n+10}	-	-	-	-	DP^F_{n+10}	CoD^F_{n+10}

DP = Default Probability; CoD = Cost of Default

An approach (as opposed to *the* approach) would be to possibly look at historic average probabilities that a bond will actually default (be downgraded) in its lifetime, and using this value to come up with a base probability to distribute equally over each of the periods of the issue, up to maturity. Next, the fund can use any information it deems informative to update the assigned probabilities. The fund will also have to update the probabilities through the reconsideration of information, as periods pass.

The previous paragraph mentioned the use of information to assign and update default probabilities. What kinds of information can possibly be useful in deflating default probabilities to realistic or objective values? In a sub-section under the Empirical Analysis and Results chapter, the risk-free term structure is briefly investigated. The section argues that a "perfect" term structure exist under conditions of perfect or rather complete information. Under such conditions long term risk-free rates are equally as uncertain as short term risk free rates. Applying the same mentality, it should thus be asked what will constitute as perfect information in the case of a corporate term structure. The exact opposite of this is of course: *what creates uncertainty in default probabilities?*

Perfect information appears to relate to the forthcoming financial statements of the issuer; being more specific, perfect information about factors influencing the (forthcoming) financial statements of an issuer. It can be argued that the default probability of a certain period moves from a Probability value to Boolean with the release of the period's financial results, and moves from Boolean to a Probability value when the financial statements of the particular period are still outstanding. This pre-emptively makes sense when considering the view of Merton (1974) on the valuation of bonds.

Furthermore, if the prior discussion regarding the first-period default probability impacting on subsequent default probabilities is true, then a certain period's financial statements must impact the default probabilities of subsequent periods. Again the Merton model pre-emptively supports this, when considered together with company growth rates - as used in equity valuation. Anyhow, these arguments are left to further research.

As a last point and deliberately ignoring Equation [7], the number of periods (duration/ time to maturity) also seems to plays a role; it becomes clearer why (default) premiums differ when different durations (maturities) are involved - it may be far easier to deflate default probabilities and thus the cost of default with information over short periods than over longer periods.

It should also be asked what unique contribution can or do credit ratings make in terms of perfect information; if and by how much ratings can help to deflate default probabilities in an objective and neutral manner. In the case of corporate issues, perfect information can not contribute or constitute more than the Default Risk premium due to default losses; thus, neither can private information.

What is more, Equation [6] and specifically Equation [20] only have three unknown variables – a) the Risk-free Term Structure; b) Periodic Default Probabilities and c) Recovery Rates. [Ratings have sole discretion over none.] Pre-emptively, the impact ratings can have on bond prices also seems to be related to an issue's maturity, as maturity determines relative exposure to these variables.

Equation [6] has important implications for Table 2 under Section 2.2: Determinants of Bond Prices, and Figure 8 under Section 2.3: The Independent Impact of Credit Ratings on Bond Prices. It also appears if the weight of default risk premium is larger than that reported under Table 2 - this will also affect (increase) the Tax premium reported under Table 2.

How tax further influences/ extends Equation [6] and thus Equation [20] was not investigated. Similarly, Equation [6] also does not make any provision for Liquidity premiums; the model is surely not all-inclusive. But the omission of this particular premium should not create significant error, seeing that Liquidity is mostly a minor bond price determinant – rather than a major bond price determinant. In addition, other proposed price determinants like Maturity, Issuer Sub-category, Business Cycles, and even Downgrade Risk were totally ignored; it is believed that these determinants are represented in the equation by the various default probability and spot rate terms, together with movement (changes) in the terms.

The model (Equation [6]) cannot really be tested over and above:

a) Fitting the model to market price data - converting price data into default probabilities, according to the relationship captured in the model; and

b) Acquiring the opinion of the market, especially investors, regarding their opinion of the model; whether they belief it better presents the nature of risky bonds and whether they in fact price or consider pricing accordingly.

The model strongly builds on the notion that, without the risk of default, risky bonds are nothing more than riskless bonds. Keep in mind the inter-relationships between periodic default probabilities (Equation [18]); now take Equation [6] and set the probability of no default over the issue's entire lifetime equal to one - the issue appears as a risk-less (Treasury) bond. Still, others may content that risky corporate bonds have unique characteristics resulting in bond premiums not mainly (90% - 95%) attributable to taxes and default losses, whatever that may be. Thus, the only way to really verify the model is to understand the core meaning of periodic default probabilities. By understanding periodic default probabilities, prediction becomes more realistic, and more realistic predictions should result in closer matches between modelled prices and market prices at any point in time. This then will either support or refute the model.

Understanding periodic default probabilities really just refer to the determinants of periodic default probabilities again. This was briefly considered in previous paragraphs, when it was asked what kinds of information can be used to deflate default probabilities. But what was not considered then was that the actual meaning of the more general and conventional word: *default probability.* This can be as insightful - what does it essentially mean to say that an issue(r) has a default probability of x?

The actual process of defaulting is easy to understand – a certain default probability implies a certain probability of default - as process - actually taking place; the company or whoever announces the case of default and commences with the normal procedures of default. But this speaks to the result, not the cause; the second step not the first step. What will one say what was the first step why the issue(r) defaulted?

As was mentioned before, Fabozzi (2000) refers to default risk as the inability to make timely payments (principal and/or interest). Is it correct to say that issue(r) i has a default probability of x, because… (upcoming) cash-flows are uncertain by z%, - or rather - that (upcoming) cash flows will be above y% is uncertain by z%? The word *cash-flows* are used here, but maybe it should rather be income/ financial statements, etc. If the above statement is true, then even this already suggests the existence of an array of default probabilities, with a strong relationship between that of the first period and those of subsequent periods.

Consider the case of a company in financial distress, therefore with a general default probability much higher than that of companies in more healthy positions. After some time, the company posts its awaited financial results, showing that it barely survived. The deep concern about the likely probability of default is not over - it is merely transferred to the next period and the next period's financial statements. On the other hand, assume that the company miraculously recovered, and that it posted most exceptional results. All the sudden, the concern over immediate default is gone, and the concern over intermediate default is less of an issue – the company has accumulated some reserves again through its exceptional performance. This should be the starting point of future research.

5 RESEARCH METHODOLOGY

5.1 Characteristics; Properties of bond events

5.1.1 *Abnormal Performance*

Although not the only one, abnormal performance is arguably one of the (bond) event properties that enjoy greatest interest. In examining the relative power of three different methodologies (models) used in event studies to measure security price performance, Brown and Warner (1980:207) note that…

"A security's price performance can only be considered 'abnormal' relative to a particular benchmark. Thus, it is necessary to specify a model generating 'normal' returns before abnormal returns can be measured…For each model, the abnormal return for a given security in any time period t is defined as the difference between its actual ex post return and that which is predicted under the assumed return-generating process."

Event-Induced Variance and the Abnormal Performance Distribution

Boehmer et al (1991) argue that events may not have an identical effect on all firms; also that events may be accompanied by increases in the cross-sectional dispersion of (security) returns. As an extension of the work of Brown and Warner (1980) and Brown and Warner (1985), Boehmer et al (1991) investigate whether event-induced increases in the variance of returns affect the ability of (stock) event-study methods to correctly detect abnormal performance (reject the null hypothesis that is). Boehmer et al (1991) note that Brown and Warner (1980, 1985) verify that event studies work well when an event has an identical effect on all firms, but that the authors also warn that, when an event has differing effects on firms, the variance of returns will increase and common methods may fail.

For evaluation purposes Boehmer et al (1991) in their study induced abnormal performance based on a normal distribution with a mean of 0%; 1%; and 2%.

Abnormal performance variance took the general form $k_i\sigma^2$, where σ^2 represents either individual security i estimation-period-residuals variance, or that of the average security's (portfolio) estimation-period-residuals. k was based on prior empirical studies of event period standard deviations and was set equal to 0; 0.5; 1; or 2. The non-zero abnormal performance variance implied that each security did not had an identical level of abnormal performance. In tests where k was equal to 0, it replicated the assessment of previous research that abnormal performance is equal to a constant.

5.1.2 *Event date certainty (uncertainty)*

"The simulations which have been performed thus far make the strong assumption that the time at which abnormal security price performance occurs is known with complete certainty. However, if it is only known when, for example, the Wall Street Journal announced that the 'event' had taken place, then the calendar date of the event cannot be pinpointed exactly and the date itself becomes a random variable; in that case, abnormal returns for a number of periods before the 'announcement date' will typically be scrutinized for evidence of 'abnormal' performance. Similarly, even when it can be established with certainty when the event occurred, one is often concerned with whether or not there exists a profitable trading rule which could be implemented conditional on an event. In such a situation, it is necessary to study abnormal price performance for the period following time '0'." (Brown and Warner 1980:224)

Also, Dallocchio et al (2006) carried out a sequence of stationarity tests over different sub-periods of increasing size to account for event date uncertainty.

5.1.3 *The expected sign of abnormal performance*

Brown and Warner (1980) note that an implicit assumption in event study tests is that the sign of the abnormal performance is known. The authors further show that, when the sign of the abnormal performance is not known a priori, the ability to discern abnormal performance is reduced markedly.

5.1.4 *Abnormal Performance – Previous Studies*

In general, previous studies relating credit changes to bond prices measured infinitesimal abnormal performance, and little cumulative abnormal performance. Bachelor and Manzoni (2006) never measured average cumulative abnormal percentage returns in excess of -0.86% (3.17%) over various event windows for downgrades (upgrades). Their results are further broken down in Table 11. Table 10 depicts the measurements of Steiner and Heinke (2001). Dallocchio et al (2006) posted Cumulative-Average-Abnormal-Return downgrade results of comparable magnitude.

In broad terms and based on the power of relevant statistical tests, the work of Boehmer et al (1991) suggests that abnormal performance levels in the region of 2% offer rejection of the null hypothesis close to 100% of the time. Levels of 1% offer “acceptable” results (between 60% and 70%). This is for events related to stocks – not bonds - though.

Table 10. Abnormal Performance - Steiner and Heinke (2001)

Day resp. period	Downgrades DAR$_t$ resp. CDAR$_{km}$	Upgrades DAR$_t$ resp. CDAR$_{km}$	Day resp. period	Downgrades DAR$_t$ resp. CDAR$_{km}$	Upgrades DAR$_t$ resp. CDAR$_{km}$
−180 to −31	−0.802	1.219	5	−0.032	0.041
−30 to −11	−0.403	0.366	6	−0.011	0.052
−10	−0.011	0.0004	7	−0.020	0.026
−9	−0.034	−0.030	8	0.004	0.016
−8	−0.050	0.008	9	0.027	−0.048
−7	0.016	0.004	10	0.036	−0.005
−6	0.004	0.038	11 to 30	0.619	−0.007
−5	−0.011	0.004	31 to 180	0.151	0.852
−4	−0.055	−0.014	0 to 1	−0.185	0.036
−3	0.006	0.002	0 to 5	−0.395	0.083
−2	−0.030	−0.005	−180 to −91	−0.124	0.431
−1	−0.011	0.037	−90 to −1	−1.256	1.167
0	−0.061	0.018	1 to 90	0.526	0.385
1	−0.125	0.019	91 to 180	−0.081	0.580
2	−0.046	−0.008	−180 to 180	−0.990	2.543
3	−0.076	0.041	−30 to 30	−0.335	0.526
4	−0.056	−0.027			

Table 11. Abnormal Performance - Bachelor and Manzoni (2006)

Event and Bond Type	No. of Cases N	Event Window (Days Relative to Re-Rating) [−60,+60]	[−60,−16]	[−15,−2]	[−1,+1]	[+2,+15]	[+16,+60]
Downgrade	105	−0.67	0.21	0.20	−0.06	−0.54	−0.48
Upgrade	28	3.17	0.57	0.82	0.33	−0.09	1.54
Downgraded bonds only							
AAA	14	0.75	−0.59	0.02	0.00	0.45	0.87
AA	51	−1.22	0.39	−0.25	0.17	−0.92	−0.61
A	40	−0.35	0.26	0.64	−0.37	−0.68	−0.20

5.1.5 *Clustering*

Although the study predominantly focuses on stocks, Brown and Warner (1980) offer excellent discussions on event-date clustering and systematic risk clustering. Both phenomena are bound to be “equally” relevant to bond markets. Clustering essentially relates to cross-sectional correlations and time-series correlations and their impact on statistical tests.

Event Date Clustering

Brown and Warner (1980) describe event date clustering by noting that the securities of a sample will frequently (each) experience an event during the same calendar time period; the authors simulated event-date clustering[74] by restricting month ‘0’ (the event month – the study utilized monthly data) of the securities in a sample to fall in a calendar month that is randomly selected, but common to all securities in the sample.

[74] Brown and Warner (1980) study the power of event study methodologies and therefore simulated abnormal performance.

Brown and Warner (1980) further state that the general impact of clustering is to increase the cross-sectional dependence of securities. Cross-sectional independence is important for two reasons:

a) Cross sectional dependence increases the variance of performance measures - if performance measures such as the deviation from historical mean returns or market model residuals are positively correlated across securities in calendar time, then such clustering will increase the variance of the performance measures (e.g. the average residual). Thus, it lowers the power of the statistical tests.

b) Cross sectional dependence affects the rejection frequencies of some statistical tests - the null hypothesis will be rejected too frequently if security specific performance measures are positively correlated and the power of the statistical test is dependent on the independence of the performance measure.

In discussing the only slight difference in rejection-frequency results of tests with event date clustering compared to tests without event date clustering, Brown and Warner (1980) caution that in an actual event study, a sample of securities whose events are clustered in calendar time may be non-random; the sample securities might be drawn from a common industry group having positively correlated performance measures. In such a case, the power of the tests is reduced even if the particular methodology abstracts from the market, and take cross-sectional dependence into account in order to assure the 'correct' proportion of rejections is appropriate in such a case. The sample used to test the effect of event-date clustering consisted out of randomly selected securities.

Systematic Risk Clustering

A particular sample may consist of securities which tend to have higher than average (or lower than average) systematic risk. Since it is known that for individual securities a positive empirical relationship exists between the variance of returns and systematic risk (as well as between market model residual variance and systematic risk), it seems reasonable to expect that tests for abnormal performance will be more powerful for low risk securities than for high risk securities; the intuition is simply that a given level of abnormal performance should be easier to detect when 'normal' fluctuations in sample security returns (and the standard errors of parameter estimates such as β) are small rather than large (Brown and Warner 1980).

5.2 Isolating Abnormal Performance

5.2.1 *Isolating Abnormal Performance of Stocks*

Although the study never actually measure Abnormal Performance pertaining to stocks, some of the models to do so are briefly investigated, in order to draw comparisons to the models or methodologies used in measuring abnormal performance pertaining to bonds. The comparison helps to introduce the measurement of abnormal performance and helps to delineate some of the underlying model-assumptions with regards to measuring abnormal performance pertaining to bonds.

It was mentioned under the introductory paragraph of this chapter that Brown and Warner (1980) examined the relative power of three different models used in event studies to measure security price performance. The three models were in fact: a) the Mean Adjusted Returns Model; b) the Market Adjusted Returns Model; and c) the Market and Risk Adjusted Returns Model. For each of these three models, the return, R_{it}, that will be realized on security i in period t is made up by the expected return, K_{it}, and the abnormal or unexpected component, ε_{it}. ε_{it} is unknown at the beginning of period t. Table 12 summarizes the three models and their respective assumptions and method of implementation.[75]

$$R_{it} = K_{it} + \varepsilon_{it} \qquad \textbf{[23]}$$

[75] The discussions on the three models are predominantly from the work of Brown and Warner (1980). The three models are also covered and utilized by Brown and Warner (1985) and Boehmer et al (1991).

Table 12. Isolating Abnormal Performance of Stocks

	Mean Adjusted Returns	**Market Adjusted Returns**	**Market and Risk Adjusted Returns**
Model Equation	Mean Adjusted Returns: [76] $\varepsilon_{it} = R_{it} - K_i$	Market Adjusted Returns: [77] $\varepsilon_{it} = R_{it} - R_{Mt}$	Market and Risk Adjusted Returns: [78] $K_{it} = E(R_{it}) = E(R_{zt}) + \beta_i[E(R_{mt}) - E(R_{zt})]$ $\varepsilon_{it} = R_{it} - [R_{zt}(1-\beta_i) + \beta_i R_{mt}]$
Assumptions	The ex ante expected return for a given security i is equal to a constant K_i which can differ across securities: $E(R_i) = K_i$. The CAPM predicts that a security's expected return is constant if it is assumed that a security has constant systematic risk and that the efficient frontier is stationary	Ex ante expected returns are equal across securities, but not necessarily constant for a given security. The model is consistent with CAPM if all securities have systematic risk equal to unity. Market-wide movements at the time of events are taken into consideration	The model presumes that some version of the CAPM generates expected returns. This method takes into account both market-wide factors and the systematic risk of each sample security
Implementation	Examine whether the event date (period) returns on a security is significantly different from the returns on the security in the time period surrounding the event	Obtain the difference between the return on a sample security and the corresponding return on the market index	Regress the returns for each sample security over a certain period around the event, against the returns on an Equally Weighted Index over the estimation period; examine the significance of the regression residuals of each security over the event period

[76] The abnormal return ε_{it} is equal to the difference between the observed return R_{it} and the predicted return K_i.

[77] Since the market portfolio of risky assets m is a linear combination of all securities, it follows that $E(R_{it}) = E(R_{Mt}) = K_t$ for any security i. The ex post abnormal return on any security i is given by the difference between its return and that on the market portfolio.

[78] See for instance the Black (1972) two-parameter Asset Pricing Model. K_{it} is the expected return, and ε_{it} the abnormal returns. R_{zt} is the return on a minimum variance portfolio of risky assets which is uncorrelated with the market portfolio. R_{it} and R_{mt} are the return on security i and that on the market portfolio, respectively.

An important difference between the Market Adjusted Returns model and Market-and-Risk-Adjusted Returns model is that the former assumes that all securities have systematic risk equal to unity - the systematic risk of all securities are the same.

5.2.2 *Isolating Abnormal Performance of Bonds*

For now, the method of isolating abnormal performance is investigated without consideration of the underlying data type (yields spreads or bond returns for instance), or the method used to statistically verify the presence of abnormal performance; both issues are covered in subsequent sections. Most of the discussion under this section is referenced against the abnormal performance models of stocks that were mentioned under the previous section.

The Market-Adjusted Returns based method

Table 27 – under Appendix B - reveals that the majority of studies relating rating changes to bond prices predominantly utilize a reference to isolate abnormal performance; the main difference is in terms of the eventual reference selected. The selected references are listed below. When comparing this approach to the models used to isolate abnormal performance of stocks, it is apparent that the underlying method most strongly resembles the Market Adjusted Returns model.

a) Matched Pair [rating; issue-subcategory; coupon] : matching the issue in question with another issue of similar pre-announcement rating; issue sub-category; maturity; and coupon rate – as used by Batchelor and Manzoni (2006) and to some extent Hawley and Walker (1992)

b) Bond Index [rating; issue-subcategory] : matching the particular issue in question with a bond index of similar re-announcement rating and issue subcategory – as used by Dallocchio et al (2006)

c) Bond Index [rating] : matching the particular issue in question with a bond index comprising of issues of similar pre-announcement rating and of comparable maturity – as used by Hite and Warga (1997) and to some extent Ingram et al (1983)

d) A composite Bond Index : comparing the issue in question with a composite bond index – as used by Wansley et al (1992)

e) A Treasury/ Government Bond or Bond Index : comparing the particular issue in question with a government/ treasury bond index, or matching the particular issue with a government/ treasury bond of similar maturity and occasionally the coupon rate – as used by Steiner and Heinke (2001) and Hand et al (1992)

Based on the eventual reference bond or index selected, the precision with which the reference resembles the issue-in-question's sensitivity to bond market risks can be examined; the Market Adjusted Returns model assumes that all securities have systematic risk of unity. The Matched-Pair Method ought to best mirror the particular issue-in-question's sensitivity to bond market risks. The second last – a common bond index - and the last – a treasury/ government bond or bond index - ought to less accurately mirror the particular issue's sensitivity to bond market factors. The higher accuracy of course comes with a price - the Matched Pair method is not always practical, especially in developing bond markets, due to a lack of individual reference bonds.

The selected reference will thus influence the eventual abnormal performance measured by the study. Put differently, the selected reference essentially determines *what* precisely is measured by the study – it is very clear what Batchelor and Manzoni (2006) is measuring and it makes perfect sense. How this resultant abnormal performance outcome impacts the results in turn depends on the (nature of the) methodology used to ascertain the significance of the abnormal performance. Whether any reduction in sensitivity/ accuracy will essentially occur can possibly be examined by utilizing the different references in the same study, or by comparing the (differences between the) relative references then.

Market and Risk Adjusted Returns based methods

Returning to Table 27, Katz (1974) and Gropp and Richards (2001) differ from the majority of the studies listed in the table with regards to the method used to isolate abnormal performance. Gropp and Richards (2001) more closely resembles the Market and Risk Adjusted Returns model; the Market and Risk Adjusted Returns model does not presuppose that all securities have systematic risk equal to unity.

Katz (1974) determined the extent with which abnormal performance (yield adjustment) took place over an eighteen-month period (-12; +5) by noting the ratio of the difference between the actual and the expected yield of the old rating class with respect to the premium differential. The expected yields of a bond were forecast for its old rating class and new rating class for each of the eighteen months considered. The premium differential refers to the difference between the expected yields of the higher and lower rated classes.

Equation [24] and Equation [25] capture the regression model developed by Katz (1974). In Equation [25], Y_t refers to yield-to-maturity at time t; M to maturity; F to total float; CR to coupon rate; and E_t to the residual term of period t. a_t, b_t, c_t, d_t, and e_t are coefficients of the regression equation in period t. The intermediary steps between Equation [25] between Equation [24] are discussed in Katz (1974).

$$\begin{aligned} Y = \int\{ & \mathrm{Re}\,al\ Interest\ Rate; Inflation\ Risk; Interest\ Rate\ Risk; Default\ Risk; \\ & Marketability\ Risk; Tax\ Effect\} \end{aligned} \qquad \textbf{[24]}$$

$$Y_t = a_t + b_t M + c_t M^2 + d_t F + e_t CR + E_t \qquad \textbf{[25]}$$

Equation [26] and Equation [27] capture the model of Gropp and Richards (2001). In equation [26], R_{it} denotes the log return of bond i in period t and R_{cmt} the log return of market portfolio m (in country c) in period t. In Equation [27], AR_{it} refers to abnormal returns of bond i in period t. Here, R_{it} is still the log return of bond i in period t, but the data is from the event window - not the estimation window. The same can be said for R_{cmt}; $\hat{\alpha}_i$ and $\hat{\beta}_i$ are coefficients from the estimation window (Equation [26]).

$$R_{it} = \alpha_i + \beta_i R_{cmt} + \varepsilon_{it} \quad \textbf{[26]}$$

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{cmt} \quad \textbf{[27]}$$

Compared to a Mean Adjusted Returns based model, and a Market Adjusted Returns based model (strongly depending on the eventual reference selected), a Market and Risk Adjusted based model may possibly better capture the individual sensitivities of individual bonds to bond market risks. Adoption of the Market and Risk Adjusted model offers the possible chance of sacrificing less accuracy whilst using the same practical data; the market model only requires data on overall bond market returns and individual bond (the bond in question) returns - an "exact" match of the individual bond in question is not required. Unfortunately, the model has assumptions and requirements of its own.

With reference to other bond studies (and not particularly the work of Katz 1974; certainly not the work of Gropp and Richards 2001) Alexander (1980) notes that, while the empirical appropriateness of applying the market model to common stock returns has been demonstrated, the assumptions of the model – the error term is normally distributed with a mean of zero; the error term is unrelated to the independent variable; the error term has no serial correlation; and the standard deviation of the residual term for firm i is homoscedastic - are seriously violated when the market is defined as a debt index. In summary Alexander (1980) notes that an interpretation of studies which entail analysis of bonds in the market model context must therefore be done with extreme caution.

The market model, according to Alexander (1980), can be written as:

$$R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it} \quad \textbf{[28]}$$

Where R_{it} and R_{Mt} denote the return for bond i and the market in month t, respectively. Alexander (1980) does offer reasons why the model-assumptions are violated (Bond Maturity; Bond Yields). Seemingly, based on the differences in inherent risk associated with issues of different ratings, the bond-returns-bond-market-returns plot is likely non-linear; and Equation [28] inaccurately accounts for this.

Therefore, for purposes of isolating abnormal performance - although the utility of a Market Adjusted and Risk Adjusted based model offers certain advantages in terms of data collection, its implementation seems somewhat hindered by the lack of a properly specified and tested model. As Alexander (1980) points out, any model specification also requires an investigation into the significance of model-assumption violations - if any - particularly in terms of error terms.

5.3 Measuring Bond Abnormal Performance

Yield-to-maturity versus bond returns - As can be seen from Table 27, both Dallocchio et al (2006) and Ingram et al (1984) based their studies on yield premiums as opposed to holding-period returns, like most of the other studies in the table did.

Swindler (1990) compared the statistical equivalence of utilizing yield to maturity versus returns in an abnormal returns model; Table 13 offers a more vivid depiction of what this entails. In the table, P_t refers to accrued interest payments of the bond, r_t represents holding period returns for a single period, and y_t is the bond's yield to maturity. Also, r_t^* and y_t^* are the holding period returns and yield to maturity of a reference bond or market index, respectively.

Swindler found that the two methodologies are not statistically equivalent. His findings suggest that using returns is the correct method for testing statistical significance. In that case, if the event being studied constitutes bad news, then using yields will seemingly result in more powerful, albeit incorrect, statistical tests. If rejecting the null hypothesis implies rejecting market efficiency, the use of yields will bias the results against accepting efficiency. On the other hand, the use of yields when there is good news will bias the results in favour of accepting market efficiency.

Table 13. Yield to Maturity versus Holding Period Returns in an Abnormal Returns Model

	Yield-to-Maturity	Holding Period Returns
General Calculation	$\theta_t = y_t - y_t^*$	$r_t = (P_t - P_{t-1})/P_{t-1}$ $\varepsilon_t = r_t - r_t^*$
Hypothesis	$H_0 : \theta_t = 0$	$H_0 : \varepsilon_t = 0$

Based on Swindler (1990)

The study of Swindler (1990) is of course more relevant to studies wishing to utilize the abnormal returns model – to the results of Ingram et al (1984). The author is not aware of any work that compares the statistical equivalence of utilizing yield-to-maturity versus returns when testing the statistical significance of abnormal performance by means of a stationarity-test, as Dallocchio et al (2006) did.

Bond Returns - Equation [29] and Equation [30] summarize the daily holding period returns formulae, as used by Steiner and Heinke (2001). K_{it} is the closing day price of bond i at day t, C_i is the coupon payment to holders of bond i, and V_i is the number of days elapsed since the last coupon payment of bond i.

Flat Price of bond i at day t, F_{it}:

$$F_{it} = K_{it} + C_i(V_i/365) \qquad \textbf{[29]}$$

Daily holding period returns:

$$R_{it} = \ln(F_{it} / (F_{it-1})) \quad \textbf{[30]}$$

Frequency of data - Brown and Warner (1985) also studied the effect of using daily data instead of monthly data in the context of abnormal performance. Noteworthy is that the power of the tests - measured as rejection frequencies of the null-hypothesis - used to test the statistical significance of abnormal performance improves with daily data.

5.4 Determining the Significance of Abnormal Performance

5.4.1 *Statistical Inference of Abnormal Performance*

Based on an Abnormal Performance sample, it is possible to statistically infer the abnormal performance population – most notably the Abnormal Performance Population Mean. By statistically testing whether the Abnormal Performance Sample Mean is significantly non-zero, it is possible to infer that abnormal performance did occur, and that ratings as event did in fact had an impact on the issues in question.

Mean Abnormal Returns and Cumulative Mean Abnormal Returns

Equation [31] and Equation [32] capture the mean abnormal returns and cumulative abnormal returns formulae, respectively – as used by Steiner and Heinke (2001).

Table 14 lists some of the statistical tests used to ascertain whether Mean-Abnormal-Returns and Cumulative-Abnormal-Returns samples and/ or sub-samples are significantly different from zero, and whether sub-samples significantly differ from each other.

Table 14. Applied parametric and non-parametric t-test statistics

Statistical test	Statistic for daily abnormal returns	Statistic for cumulative abnormal returns
Simple t-test	$t=\sqrt{N}\dfrac{\mathrm{DAR}_t}{\sqrt{\dfrac{1}{N-1}\sum_{i=1}^{N}(\mathrm{AR}_{it}-\mathrm{DAR}_t)^2}}$	$t=\sqrt{N}\dfrac{\mathrm{CDAR}_{km}}{\sqrt{\dfrac{1}{N-1}\sum_{i=1}^{N}(\mathrm{CAR}_{ikm}-\mathrm{CDAR}_{km})^2}}$
Brown and Warner (1985) t-statistic	$t_{\mathrm{BW}}=\dfrac{\sum_{i=1}^{N}\dfrac{\mathrm{AR}_{it}}{\sqrt{\dfrac{\sum_{t=k}^{t=m}\left(\mathrm{AR}_{it}-\dfrac{1}{\lvert m-k\rvert+1}\sum_{t=k}^{t=m}\mathrm{AR}_{it}\right)^2}{m-k}}}}{\sqrt{N}}$	$t_{\mathrm{BW}}=\dfrac{\sum_{i=1}^{N}\dfrac{\mathrm{AR}_{it}}{\sqrt{\dfrac{\sum_{t=k}^{t=m}\left(\mathrm{AR}_{it}-\dfrac{1}{\lvert m-k\rvert+1}\sum_{t=k}^{t=m}\mathrm{AR}_{it}\right)^2}{m-k}}}}{\sqrt{(m-k+1)N}}$
Wilcoxon sign rank test	$z=\dfrac{W^{+}-\dfrac{N(N+1)}{4}}{\sqrt{\dfrac{N(N+1)(2N+1)}{24}}}$	
Corrado (1989) rank sum test	$z_{\mathrm{C}}=\dfrac{\dfrac{1}{\sqrt{N}}\sum_{i=1}^{N}\left(\dfrac{K_{it}}{1+M_i}-0.5\right)}{\sqrt{\dfrac{1}{G}\sum_{t=1}^{G}\left(\dfrac{1}{N}\sum_{i=1}^{N}\left(\dfrac{K_{it}}{1+M_i}-0.5\right)\right)^2}}$	$z_{\mathrm{C}}=\dfrac{\dfrac{1}{\sqrt{N}}\sum_{i=1}^{N}\sum_{t=k}^{m}\left(\dfrac{K_{it}}{1+M_i}-0.5\right)}{\sqrt{(m-k+1)\dfrac{1}{G}\sum_{t=1}^{G}\left(\dfrac{1}{\sqrt{N}}\sum_{i=1}^{N}\left(\dfrac{K_{it}}{1+M_i}-0.5\right)\right)^2}}$

Where t, statistic of simple t-test; t_{BW}, Brown and Warner (1985) t-statistic; z, Wilcoxon z; W^{+}, sum of ranks belonging to positive abnormal returns; N, number of observations; z_{C}, Corrado (1989) z; K_{it}, individual rank K of abnormal return of bond i on day t; M_i, number of non missing values of bond i; G, maximum rank.

Source: Steiner and Heinke (2001)

Mean abnormal returns:

$$DAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it}$$

$$AR_{it} = R_{it} - R_{Bt} \qquad \textbf{[31]}$$

Cumulative mean abnormal returns:

$$CDAR_{km} = \sum_{t=k}^{m}\frac{1}{N}\sum_{i=1}^{N} AR_{it} \qquad \textbf{[32]}$$

5.4.2 *(Non)-Stationarity*

A common characteristic among the predominantly US-based bond-pricing studies thus far is the reality of relatively large sample sizes. Not only does this allow statistical inference by means of statistically testing mean abnormal returns and cumulative mean abnormal returns, it is even possible to compare sub-samples with one another. Unfortunately, not all bond markets enjoy the privilege of large sample sizes.

Dallocchio et al (2006) propose a complementary alternative to the abnormal returns method. Dallocchio et al (2006) employed a stationary test - the Phillips-Perron stationary test to be exact. The authors selected the Phillips-Perron test above the Dickey-Fuller stationary test, as the test is preferred in cases of heteroskedasticity. The test's formulae are captured by Equation [33]; in the equation, y_t refers to relative spreads on a single bond.

According to Dallocchio et al (2006), the null hypothesis attests the presence of a non-stationary stochastic process, whereas the alternative hypothesis attests that of an asymptotically stationary process. The rejection of the null-hypothesis implies that the series is stationary, accepting the null-hypothesis implies non-stationarity. In case of stationarity of the series over the window period, the rating announcement is considered to have no impact on the bond market. In case of non-stationarity, the announcement is considered to have an impact on the bond market.

Phillips-Perron test with a constant and no trend:

$$y_t = \alpha + \rho y_{t-1} + \varepsilon_t; \quad \Delta y_t = \alpha + \beta y_{t-1} + \varepsilon_t$$

$$H_0 : (\beta = 0) \Leftrightarrow (\rho = 1)$$

$$H_1 : (\beta < 0) \Leftrightarrow (\rho < 1) \qquad \textbf{[33]}$$

5.5 Methodology of the study

The methodology to be adopted should be a credible method of measuring the price-impact of rating announcements, given the bond market scenario; the methodology should isolate the price impact caused by the rating announcement from any other premiums caused by other bond price determinants to the best of its ability. The expected sample size of the study is clearly an issue, aggravated further by the fact that most methodologies have some sample size prerequisite; the eventual methodology should be able to accommodate a small sample size. A small sample size relates to the nature of the particular market, characterized by its relative youth. Few references, whether individual or group-based, may be available. Price data is readily available and conversion between various abnormal performance measures is not really a practical limitation.

Isolating abnormal performance

In isolating abnormal performance, the choice really is between a market-adjusted based model and a market-and-risk-adjusted based model. This study plans to build on a market adjusted model. The market adjusted model seems the safest choice, given that no prior research has been done on the topic in the particular market.

Validity - the extent to which the methodology (actually) measures the true price impact - is dependent on the accuracy with which bond price determinants can be isolated. Given that the study builds on the market based model, this in turn is dependent on reference selection and the relative availability of references. With regards to this, the possibility of corporate references as opposed to government references is to be examined; if found to be impractical, the study plans to revert to the utility of “risk-free” bonds as references.

The utility of corporate references supposedly offers the advantage that only the incremental spread (yield spread or abnormal returns) is isolated, which in turn can be directly associated with the particular event being studied. [This is really conditional on market conditions.] The utility of “risk-free” bonds as references only assumes unit risk (comparable risk) in terms of the risk-free rate and thus only offers a measure of total yield spread; isolating the incremental yield spread attributable to the event requires more “innovation” in approach.

The study opts against the utility of bond indices, mostly due to the lack of such indices in the particular market and also because their use is not seen as offering any incremental contribution to the isolation of risk factors. Rather indices are seen as an aggregation of risk factors. Particularly true in the South African context, indices are not that diverse in their construction; member-selection in terms of maturity, coupon rate, issuer sub-category and rating leaves lot to be desired. [Future research is welcome to test the significance of this assertion.] Bond indices would have been more of a consideration if large price movements – proportional to total yield spreads – were expected in response to rating changes, and the aim of the study was merely to validate this "*known fact*".

Measuring abnormal performance

Possibly in contradiction to other markets, it appears as if the South African market place more emphasis on yields data than (daily) returns data. Most market correspondence is yields based. With regards to the study, the unit of measure also depends on the statistical test to be used, and possibly the underlying model the study is based on. Clearly the utility of returns data is preferred over the utility of yields data in some cases - prior research showed that yields data may be less appropriate when following the abnormal returns methodology for instance – but it is not clear whether this is always the case.

Similar to the study of Dallocchio et al (2006), the study will be based on yields data. The study is to use daily data as opposed to weekly or monthly data; the window period of the study is specified under the next section.

Testing the significance of abnormal performance

To test whether rating actions significantly impact bond prices – to test whether the measured abnormal performance is significant - the study plans to follow the methodology proposed by Dallocchio et al (2006). The stationarity-test has the advantage that it can be used on smaller sample sizes. The methodology also promises to be more accommodating to the use of government bonds as the one and only reference should a lack of corporate references become apparent; the test places more emphasis on the nature/ direction of movement rather than on the absolute value.

The study deviates from Dallocchio et al (2006) on one point however. The Phillips Perron Test is a unit root test really, and not so much a stationarity test per se. The study plans to use the Kwiatkowski-Phillips-Schmidt-Shin Test in conjunction with the Phillips Perron Test; the Kwiatkowski-Philips-Schmidt-Shin Test is in fact a stationarity test.[79] The difference lays in the null-hypothesis specification – as Dallocchio et al (2006) correctly outlined, the null-hypothesis of the Phillips Perron Test is that of difference stationarity (non-stationarity – the presence of a unit root), whilst the null-hypothesis of the Kwiatkowski-Phillips-Schmidt-Shin Test is that of trend stationarity.

This impacts what is really being tested – the study agrees with Dallocchio et al (2006) that a non-stationary price series implies that the rating significantly impacted the bond price, and that a stationary price series implies no impact. But, according to Section 3: Research Hypothesis the null hypothesis is that of no significant impact and the alternative hypothesis that of significant impact. This in turn corresponds with the Kwiatkowski-Phillips-Schmidt-Shin test (stationarity tests) and not so much the Phillips Perron test (unit root tests) – in this regard the Phillips Perron Test is quite the opposite. Both tests are generally non-parametric.

Contamination is another useful technique to validate that measured market reactions are due to the factor under investigation and not due to other influences - it therefore promises to improve validity. The technique has been used in studies similar to this one; Hand et al (1992) and Hite and Warga (1997) included contamination tests in their work, although they found little evidence that it impacted results. In this study, the technique is used to verify instances where a significant impact is indeed found (see also Dallocchio 2006). As the observations' calculations are not aggregated, it is possible to apply the technique post statistical analysis and not pre sampling.

[79] Refer to Phillips and Perron (1988); Kwiatkowski et al (1992). For more background on both tests see for instance Davidson and MacKinnon (1993); Hamilton (1994) or Hayashi (2000)

Significance-level

Event studies normally report results against significance levels between 1% and 10% (1%, 5%, or 10%). This study sees no reason to use a significance level greater than 10% and will use the same reporting style (1%, 5% or 10%).

6 DATA AND SAMPLING[80]

6.1 Population

In general, the study wishes to make inferences about the effect of rating announcements on bond prices within South Africa. Broadly speaking, the study has an ideal population comprising of most or all bond issue types listed on the South African Bond Exchange over an extensive period of time. A more realistic population requires restrictions in terms of the period and issue-types.

One reason to limit the period of the study is that it is believed the rating process has changed (improved) over time (see for instance Cantor 2004). The youth of the market is another reason.

Issue-types are restricted as not all issues are equally susceptible to rating actions – take short term notes versus long-term bonds for instance - and not all issues have reasonable populations to allow any proper investigation. Furthermore, differences in pricing between different issue-types are also of practical importance.

List A (page xvi) captures the issue-types listed on BESA. Figure 19 and Table 30 show the number of listed issues (expired plus non-expired) per issue-type. Figure 20 and Table 31 show the value of listed issues (expired plus non-expired) per issue-type.[81] These tables and figures clearly show the relative youth of the South African bond market. Based on Table 31, the bulk of the market (85.69%) constitute out of Vanilla Bonds and Commercial Paper.

Ignoring practicalities emanating from pricing differences for a moment, Table 32 shows that Amortizing Instruments, Exchange Traded Funds, Negotiable

[80] All the tables and figures referred to in this section were compiled using data from BESA (2007). The actual tables and figures appear under APPENDIX J
[81] Note that the figures and tables show the number of new listings per year, as well as the value of new listings per year. The tables and figures do not reveal the number of active (non-retired) listings per year and their total value.

Certificates of Deposit; and Perpetuities have too small populations. These issues are ignored.

Table 33 reveals that Commercial Paper, Equity Structured Notes, Weighted Floating Rate Notes, Customized Instruments, and Credit Linked Notes all have small populations when maturities over one year are considered. Based on Table 31, Equity Structured Notes, Weighted Floating Rate Notes, Customized Instruments, and Credit Linked Notes also constitute only a small percentage of the market (1.99%).

Amortizing Floating Rate Notes, CPI-linked issues, Floating Rate Notes do in fact have long-term exposure, but their pricing differ from that of Vanilla Bonds. These issues are also excluded from this study; these issues collectively make up 12.23% of the market.

Table 34 indicates that most of the Vanilla Bonds are rated investment grade, with only two issues below investment grade.[82] Furthermore, most of the investment grade issues are upper medium and up, with only nine issues falling in the lower medium grade category.

6.2 The Sampling Process

Issue-types – The previous sub-section discussed the issue types this study will focus on; sampling will only be from the relevant issue types. Only local-currency denominated bonds of local corporates are considered. Furthermore, callable vanilla bonds are also discarded. Both issues that have already retired and issues that have not yet retired are considered if they are affected by a rating change and fall within the study period.

List C captures the remaining sampling filters that previous studies have used, over and above special features impacting the issue's pricing and contamination – the removal of "contaminated" issues.

[82] Table 34 is based on issue-specific data obtained from BESA. Issue ratings were sampled at a particular point in time; the table should thus rather be seen as a rough indicator of rating distributions.

List C. Sampling Criteria

Double rating change	For lengthy study periods and even window periods it is not entirely impossible for a bond to undergo a second (multiple) rating announcement(s). These issues are normally (sometimes) excluded or limited to only one announcement - also see *Clustering of companies*
Clustering of companies	Window periods are based on (rating announcement) event dates. Rating events are limited to one observation per company; should it happen that for the given window period a rating announcement impacts more than one issue from the same issuer, a selection based on "best-fit" is considered to allow only one observation per company per window period. This procedure aims to avoid clustering of results, and can possibly be extended to the study period (only one issue per issuer for the study period)[83]
Event-date clustering	Event-date clustering refers to the occurrence of more than one rating event around the same announcement date; event-date clustering may impact the study's resultant price data sample, by increasing serial- and cross-sectional correlations. Although exclusion can't reverse the impact of Event date clustering on the price data, certain issues are sometimes excluded in order to get a more balanced representation across the study period, rather than a representation mostly centred on a sub-period within the study period.
Liquidity	An observation's liquidity is normally verified before the observation is included in the sample. Only events that prove to be liquid over the relevant window period is then included; observations that do not trade for periods longer than a number of days are normally excluded.

[83] This includes cases where separately rated issues of the same issuer experience a rating announcement, but not on the same date, and their window periods eventually overlap.

The proposed methodology does not require as stringent measures with regards to the occurrence of double rating changes or the clustering of companies, as events are studied on an individual basis. In fact, by allowing it (including such occurrences), it would be possible to reflect on the impact of these phenomena on the results in a unique way.

Given that the market to be studied is a developing market, liquidity requirements were also relaxed. Including observations with poor trade in the sample under study may invoke objections under certain circumstances. Two points are raised in defence.

Firstly, the origin of price data - the type of price data considered - may impact the liquidity criteria. Given that this study sources price data from an exchange market in which quoted prices represents prices at which trade will actually take place, the price data may very well be taken as an accurate indication of the value of the issue.[84] Under certain conditions increased trade is expected when information of value is injected into a market. Thus, if trade did not take place around event dates, investors either could not trade or did not see the need to trade.

Secondly, the validity or relevance of the liquidity criteria also depends on the statistical test to be used. Some tests and methodologies, especially the stationarity tests applied to individual price series, may be less vulnerable to non-synchronous trading and its consequences, namely increased serial correlations.

Therefore, instead of merely excluding potential observations with poor liquidity in terms of trade, these issues are included, provided that volume data are being reported on.

[84] The price data is discussed further under a subsequent Section - 6.3: Data collection.

6.3 Data collection

Rating Data

It is clear from Table 32 that Fitch followed by Moody's are the dominant rating agencies in South Africa - based on the number of ratings issued. But Table 35 shows that coverage of an issue by more than one agency is limited; it can also be seen from Table 32 that both Standard-and-Poor's as well as CA Ratings have numerous Vanilla bonds under rating. Thus, the sample size can be increased by interrogating multiple rating databases. Unfortunately, practicalities limited data collection to only rating data from Fitch.[85]

Data collection firstly comprised of isolating rating changes and then collecting rating histories on these events. Mostly rating histories on issuers that is; very few (virtually none at all) vanilla issues are individually rated in conjunction with an issuer rating. In cases where no issue-rating was available, the issuer-rating was taken as the issue's particular rating. Characteristic about the data-collection endeavour was that no "single" or "physical" database existed; accessing rating data was not as simple as referencing a "database of events". Rather it implied sifting through rating history records for rating changes.

The initial period considered stretched from prior 1994 to 2007. This specification was based on economic history and it was also informed by Table 30. Table 30 shows the number of listed bond issues based on issue date. As Table 30 alludes to, it was soon discovered that the majority of rating changes affecting vanilla bonds occurred only after late 2003. Thus rating data was considered over the period 2003 to 2007.

Issue-specific Data and Price Data

The more issue-specific data was obtained from the BESA database. This included issue-dates, maturity-dates, bond issue-types and the issued

[85] Data collection occurred right in the middle of the US sub-prime crisis, and may have negatively affected the feasibility of the study from a rating agency perspective.

amount. The particular issuer-subcategories of issues and issuers were collectively gathered from BESA and the rating database. At this point, all the issue-specific factors noted under section 2.4 can be investigated with the collected data.

Price data on both corporate bonds and government bonds were obtained from I-Net Bridge; I-Net Bridge predominantly serves as a (price) data channel for BESA and other exchanges, the data is chiefly captured and processed by BESA.

Given the nature of Treasuries in South Africa, particularly in terms of (the lack of) issuance[86], government bonds were utilized as risk-free rates in computing corporate bond yield spreads. Each corporate bond was matched as closely as possible to a government bond with regards to maturity date. Close matches of course did not exist in all cases; some of the corporate issues had maturity distance (the difference in maturity) of a few months, as opposed to a few days or weeks. Perfect matches in terms of coupon-rate also did not exist in all cases.

Volume data were also collected on government bonds and corporate bonds used in the study; the data was gathered from I-Net Bridge.

In this study, reliability – the accuracy and precision of the abnormal performance measurement procedure - is also dependent on the bond price databases the study references. The study considered price data from an exchange market (BESA) over price data from a dealer market. Unfortunately, very little information was gathered on the dealer market: a) the degree of difference in volume traded between the exchange market and the dealer market, and b) whether the dealer market in fact has price data records that can be utilized for the purposes of this study.

[86] The South African Reserve Bank predominantly issues Treasury Bills, not so much longer term Bonds. Seemingly, government bonds have taken the place of Treasury Bonds. With regards to its monetary policy implementation framework and its refinancing system, the South African Reserve Bank recognizes rand dominated government bonds as category 1 securities.

The key question really is whether volume traded in the dealer market is substantially greater *and* more frequent than in the exchange market. If so, it may very well benefit the study to rather consider price data from the dealer market – given that the market actually has price data records that can be accessed (see also Trawinski 2001). If records are in fact available, it should also be enquired whether these are based on transaction prices or bid/ ask quotes. - If transaction prices are not available, whether bid/ask quotes can be taken to fairly represent transaction prices – given the characteristics/ dynamics of the dealer market and the differences between the dealer market and the exchange market.

Overall, the study presumes that - for the purposes of the study - there is no difference between price data originating from the dealer market and price data originating from the exchange market.[87] Put differently, it is assumed that the utility of price data from an exchange market as opposed to a dealer market will not influence the results of the study.

Window Period – The period over which abnormal returns - but more importantly, cumulative abnormal returns patterns - can develop can be as long as six months before and after a rating announcement (see for instance Hite and Warga 1997; Steiner 2001). For each observation in the eventual sample of issues with rating changes *daily* bond price data was collected over two window periods.

Window Period 1	One year around the rating change date, i.e. - 180 days prior to the announcement, up to 180 days thereafter
Window Period 2	Three months around the rating change date, i.e. - 45 days prior to the announcement, up to 45 days thereafter

[87] This is exactly the research question of both Hong and Warga (2000) and Trawinski (2001).

Due to the nature of trading days, these window periods of course result in fewer price-observations than the number of days in the window period.

6.4 The Sample

In total, thirty-two issuers experienced a rating change during the study period. Of these, twenty-four were South African as opposed to African issuers. Furthermore, of these twenty-four South African issuers, twenty-one were corporate issuers. Of the twenty-one issuers, only ten had issued vanilla bonds that could be used to link actual price data to the rating changes. This resulted in a total of ninety-one issues potentially impacted by the rating changes.

Discarding the issues of issuers that were issued after the rating change or that matured prior to the rating change (forty-seven), as well as callable issues (twenty-seven)[88] and issues with no pricing data (seven)[89], left ten issues impacted by a rating change that could be studied. The number of issuers dropped to five; of the afore-mentioned ten issuers three issuers had issued vanilla bonds, but none of these bonds were affected by a rating change (the issues span outside the relevant rating change), and two issuers were discarded because they only had callable bonds affected by the rating change.

Table 17 captures the vanilla bond issuers investigated in this study. Harmony Gold Mining Company is the only issuer that experienced more than one rating change in the study period, with issues that can be studied. Furthermore, its issue makes it possible to only study the issuer's first two rating downgrades – the issue matured prior to the third rating downgrade. FIRSTRAND BANK (three) and STANDARD BANK (four) each contribute more than one issue to the sample.

[88] BESA lists callable vanilla bonds together with non-callable vanilla bonds.

[89] These were mostly zero-coupon bonds. Essentially, it still would have been in order to actually include these issues; a bond can be seen as a collection of smaller (zero-coupon) bonds (the coupons and par) and the rating change may very well have impacted the present value of the par cash flow. Nevertheless, no price data existed for these issues - these issues were not priced (correctly) or the data is missing/ was not captured.

It can be seen from Table 17 that most of the issuers are from the financial or banking sector. Three (two) of the five issuers experienced upgrades (downgrades). This translates into two issues (three events) that experienced downgrades, and eight issues that experienced upgrades – refer to Table 18.

According to Table 15 and Table 16, all of the rating changes - whether upgrades or downgrades - are only by one notch. Furthermore, only one rating change – a downgrade - moves from upper medium investment grade to lower medium investment grade. This particular case is also the worst rating change case in terms of the "lowest rating" case. None of the pre-event or post-event ratings are below investment grade.

The average time to maturity at the time of rating change is 1193 days (3y 3m 23d) overall (for all issues), 675 days (1y 10m 15d) for issues experiencing downgrades, and 1387 (3y 10m 7d) for issues experiencing upgrades; the calculation is based on a 360-day year. One of the reasons why this is reported is that it gives some indication of the amount of coupons involved in (affected by) the rating changes.

Because it is such a small sample, a separate sample of callable vanilla bonds is also introduced. The sample is not all inclusive of all callable bonds that experienced rating changes over the study period, and is separately analyzed from the main sample of non-callable vanilla bonds. The sample is merely used to complement the results of the main sample. Table 19 introduces two additional issuers, of callable vanillas that is; Table 20 lists these callable vanillas (nine). The maturity dates are quoted as the callable dates. The issuers contribute an upgrade and a downgrade; the issues contribute two downgrades and seven upgrades. Again, the rating changes for both issuers are only by one notch.

Although not as rigidly applied, analysis of callable-vanillas more or less follows that of non-callable issues – abnormal performance (yield spreads) are isolated to determine relative movement. Generally, two scenarios may emerge – no movement versus some movement. In the case of movement, a price movement attributable to the call-option should be considered in addition to causes of price-movement of non-callable issues: price movement caused by a rating change or the publishing of additional information (contamination) affecting bond price determinants.

Table 15. Distribution of Downgrades

Number of issues	Pre-Event Rating	Post-Event Rating	Grade	Notches
1	AA (zaf)	AA- (zaf)	High Investment grade » High Investment grade	(-) 1
1	A (zaf)	A- (zaf)	Upper medium Investment grade » Upper medium Investment grade	(-) 1
1	A- (zaf)	BBB+ (zaf)	Upper medium Investment grade » Lower medium Investment grade	(-) 1

Table 16. Distribution of Upgrades

Number of issues	Pre-Event Rating	Post-Event Rating	Grade	Notches
1	A+ (zaf)	AA- (zaf)	Upper medium Investment grade » High Investment grade	(+) 1
2	AA- (zaf)	AA (zaf)	High Investment grade » High Investment grade	(+) 1
5	AA (zaf)	AA+ (zaf)	High Investment grade » High Investment grade	(+) 1

Table 17. Issuers of Vanilla Bonds that experienced rating changes – 2003 to 2007

Issuer	Issuer Sub-category	Rating Implication	Event Date	Pre-Event Rating	Post-Event Rating
ANGLOGOLD ASHANTI LTD	Industrial (Mining)	Downgrade	2005/11/28	AA (zaf)	AA- (zaf)
FIRSTRAND BANK LTD	Banking	Upgrade	2005/12/08	AA (zaf)	AA+ (zaf)
HARMONY GOLD MINING COMPANY	Industrial (Mining)	Downgrade	2006/10/05	BBB+ (zaf)	BBB (zaf)
		Downgrade	2005/05/25	A- (zaf)	BBB+ (zaf)
		Downgrade	2004/08/17	A (zaf)	A- (zaf)
		Upgrade	2002/05/30	A- (zaf)	A (zaf)
INVESTEC BANK LTD	Banking	Upgrade	2007/12/11	A+ (zaf)	AA- (zaf)
STANDARD BANK OF SOUTH AFRICA LTD	Banking	Upgrade	2004/06/09	AA (zaf)	AA+ (zaf)

Table 18. Issues that experienced rating changes – 2003 to 2007

Issue	Issuer	Coupon Rate	Pre-event Rating	Pre-event Rating	Issue Date	Maturity Date	Event Date	Time to Maturity	Issued Amount (R' Mil)
AG01	ANGLOGOLD ASHANTI LTD (↓)	10%	AA (zaf)	AA- (zaf)	2003/08/28	2008/08/28	2005/11/28	2y 9m	2,000
HAR1	HARMONY GOLD MINING COMPANY (↓)	13%	A (zaf)	A- (zaf)	2001/06/08	2006/06/14	2004/08/17	1y 9m 27d	918.314831
HAR1	HARMONY GOLD MINING COMPANY (↓)	13%	A- (zaf)	BBB+ (zaf)	2001/06/08	2006/06/14	2005/05/25	1y 19d	918.314831
FRBN01	FIRSTRAND BANK LTD (↑)	13%	AA- (zaf)	AA (zaf)	2004/03/04	2010/08/31	2005/12/08	4y 8m 22d	600
FRBN02	FIRSTRAND BANK LTD (↑)	12%	AA- (zaf)	AA (zaf)	2004/03/31	2006/02/28	2005/12/08	2m 20d	100
FRBN03	FIRSTRAND BANK LTD (↑)	10%	AA (zaf)	AA+ (zaf)	2004/04/22	2008/02/28	2005/12/08	2y 2m 20d	130
IV01	INVESTEC BANK LTD (↑)	16%	A+ (zaf)	AA- (zaf)	2000/06/17	2012/03/31	2007/12/11	4y 3m 19d	526
SBK4	STANDARD BANK OF SOUTH AFRICA LTD (↑)	12.5%	AA (zaf)	AA+ (zaf)	2002/06/26	2005/02/15	2004/06/09	8m 6d	1,000
SBN6	STANDARD BANK OF SOUTH AFRICA LTD (↑)	13%	AA (zaf)	AA+ (zaf)	2004/02/16	2009/08/31	2004/06/09	5y 2m 21d	103.31224777
SBN7	STANDARD BANK OF SOUTH AFRICA LTD (↑)	13%	AA (zaf)	AA+ (zaf)	2004/02/16	2010/08/31	2004/06/09	6y 2m 21d	103.31224777
SBN8	STANDARD BANK OF SOUTH AFRICA LTD (↑)	13%	AA (zaf)	AA+ (zaf)	2004/02/16	2011/08/31	2004/06/09	7y 2m 21d	103.31224777

Table 19. A number of Issues of Callable Bonds that experienced rating changes – 2003 to 2007

Issuer	Issuer Sub-category	Rating Implication	Event Date	Pre-Event Rating	Post-Event Rating
NEDBANK LTD	Banking	Downgrade	2003/12/24	AA (zaf)	AA- (zaf)
SANLAM LIFE INSURANCE LTD	Financial	Upgrade	2007/04/11	AA- (zaf)	AA (zaf)

Table 20. A number of Callable Issues that experienced rating changes – 2003 to 2007

Issue	Issuer	Coupon Rate	Pre-event Rating	Post-event Rating	Issue Date	Maturity Date	Event Date	Time to Maturity	Issued Amount (R' Mil)
NED1	NEDBANK LTD (↓)	11.30%	AA- (zaf)	A+ (zaf)	2001/09/20	2006/09/20	2003/12/24	2y 8m 26d	2,000
NED2	NEDBANK LTD (↓)	13.15%	AA- (zaf)	A+ (zaf)	2002/07/01	2007/07/09	2003/12/24	3y 6m 15d	4,000
SBN2	STANDARD BANK OF SOUTH AFRICA LTD (↑)	13%	AA (zaf)	AA+ (zaf)	2004/02/11	2010/08/31	2004/06/09	6y 2m 21d	51.729
SBN3	STANDARD BANK OF SOUTH AFRICA LTD (↑)	13%	AA (zaf)	AA+ (zaf)	2004/02/16	2009/08/31	2004/06/09	5y 2m 21d	103.33922419
SBN4	STANDARD BANK OF SOUTH AFRICA LTD (↑)	13%	AA (zaf)	AA+ (zaf)	2004/02/16	2010/08/31	2004/06/09	6y 2m 21d	103.33922419
SBN5	STANDARD BANK OF SOUTH AFRICA LTD (↑)	13%	AA (zaf)	AA+ (zaf)	2004/02/16	2011/08/31	2004/06/09	7y 2m 21d	103.33922419
SBN9	STANDARD BANK OF SOUTH AFRICA LTD (↑)	13%	AA (zaf)	AA+ (zaf)	2004/02/19	2009/08/31	2004/06/09	5y 2m 21d	101.25237130
SLI1	SANLAM LIFE INSURANCE LTD (↑)	9.54%	A+ (zaf)	AA- (zaf)	2006/08/15	2013/08/15	2007/04/11	6y 4m 4d	1,160
SLI2	SANLAM LIFE INSURANCE LTD (↑)	9.64%	A+ (zaf)	AA- (zaf)	2006/08/15	2016/08/15	2007/04/11	9y 4m 4d	828

7 EMPIRICAL ANALYSIS AND RESULTS

It was mentioned under the methodology chapter that one of the very first tasks would be to clarify the availability of corporate references for the purposes of referencing in this study. Thus, this is reported on first before any other results are discussed.

Isolating Bond Price Determinants and Abnormal Performance – the Availability of Corporate References

The graphs under APPENDIX B compare the yield spreads of issues under study with that of potential reference bonds, for the two window periods. The word *potential* is used as these bonds represent the closest matches that could be found, rather than (more) exact matches – refer to Table 28 under APPENDIX B. Potential Corporate References were identified by short-listing issues based on maturity dates, issuer subcategory (banking, financial, utility, industry/ manufacturing), rating (comparable range as opposed to an exact match) and coupon rates (comparable range as opposed to an exact match).[90]

The South African market does not appear to be accommodating of the matching technique as reference methodology; the yield spreads of the bonds in the graphs do not really converge and are rather incomparable.[91] Should these issues be used as references, differential yield spreads – the yield spread of the issue under study minus the yield spread of the corporate reference - will initialize non-zero, particularly with a stationarity test as part of the methodology (the test is applied to single issues, not to the summation of a group). This may not be as serious, but the possible reason(s) why the yield spreads differ should be kept in mind.

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[90] The identification of reference bonds for callable vanillas - if even possible - is a bit more complex than simply isolating another callable bond matching the first in both the call date (maturity date in case call option is exercised) planned maturity date (maturity date in case the call option not exercised). It was therefore completely ignored to compare the yield spreads of callable bonds.

[91] A more suited assessment would of course be to statistically ascertain the statement. In limiting the study, this approach is not followed here and a non-convergence in average yield spreads is seen as a valid method to differentiate between yield spreads.

Also, with this context in mind, corporate references may not offer any incremental benefit over government references in terms of isolating (specific) bond price determinants and/ or changes in these determinants. It is not certain how abnormal returns calculations will turn out under this corporate reference scenario; it was not tested and is subjectively and intuitively perceived negative. Incomparable yield spreads are understandable; the bonds are truly not that similar; the market does not possess over that many bonds similar (exact) in nature.

The graphs also reveal a potential drawback to the utility of corporate bonds for purposes of referencing. This approach requires (assumes) that, as in the past, the risk-nature of the reference bond remains the same (comparable) for the duration of the event period. In some of the graphs, the reference bond's yield spread changes after the event date and sometimes even before the event date; even the reference bonds are far more non-stationary than stationary – whether with or without time trend.

The question is whether this is due to factors common to both bonds (for instance a business cycle change, and both bonds being from the same issuer-subcategory), given that they (used to) share a similar risk profile, or whether it is due to more issue specific reasons (for instance, a change in the reference bond's default risk/ probability), thereby disqualifying the reference bond as a proper reference.

Using a "dirty" (erroneous) reference bond – a reference bond affected by an issue specific event, not a common event - will inject a price error during referencing and may negatively impact the accuracy and validity of the end-results. Whether this injection will measure significant or even economical is not certain. Since the corporate reference may turn "bad" any time during the event window, it may be necessary to apply the contamination technique – as a quality check - on reference bonds as well, particularly when the reference bond experiences a "drastic" price movement during the event period.

The discussion thus far clearly relapses to the advantages of a market and risk adjusted model over a mere market model, given that such a model can be clearly specified.

As a result of the lack of corporate references, the study is forced to revert to government bonds (resembling risk-free bonds) as reference and the only reference. Fortunately, the stationarity test methodology promises to be accommodating and robust enough to detect whether a significant change or movement occurred in the total yield spread, as opposed to the incremental yield spread. It is not clear if and how this will impact end-results; although a practical delimitation, examining total yield spreads is not the same as examining yield spread differences - the abnormal performance measure changes. On the other hand, a perfect abnormal performance measure negates the need for a study such as this one.

7.1 The Nature of Corporate Bond Pricing

Risk-free rate derivation in pricing corporate bonds

When pricing risky corporate bonds, a risk-premium is added to a base rate – an appropriate risk-free rate. The conventional method to obtain an appropriate risk free rate is to use the yield on a comparable individual risk-free bond…

Given that the study utilizes government bonds as references, one such a bond was selected for each individual corporate issue under study. The process of selecting government bonds as references involved sorting a list (population) of government bonds according to the difference between the government bond's maturity date and the maturity date of the corporate issue in need of a reference - hereafter simply the *maturity distance* between a government bond and a (the) corporate bond. Exact matches were of course infrequent.

In some cases, although a government bond with (almost) identical maturity date could not be found, a number of government bonds offering short maturity distances existed, with the distance between these government bonds also small, thereby allowing an array of choices. In addition, in some of these cases the final decision could be guided by referencing a bond market update from a respectable banking/ financial institution; the update was seen as reflecting market opinion. The update relayed yield spreads, and together with this, the government bond reference that was used to calculate the spread.

Nevertheless, given that for the purposes of referencing a number of close matches existed, it is easy to intuitively believe that a remarkable difference between any government bond reference selection and any other government bond reference selection ought not to exist - under ideal circumstances it may be added.

APPENDIX C contains the yield spread graphs of the non-callable issues under study, referenced to a number of government bonds with short maturity distances[92]; those of the callable issues are also showed, albeit separately. The yield spread plots with least movement are predominantly those of the best government reference choice and also the ones corresponding with the market view. Also note that all the eventual government reference choices are predominantly liquid ones – see APPENDIX F. With regards to the graphs of APPENDIX C, the difference between the various plots of a graph is simply the difference between the yields on the selected government bonds.

$$\begin{aligned}\Delta(Yield_i \mid Yield_a^{gov}; Yield_i \mid Yield_b^{gov}) &= (Yield_i - Yield_a^{gov}) - (Yield_i - Yield_b^{gov}) \\ &= Yield_b^{gov} - Yield_a^{gov} \qquad \textbf{[34]}\end{aligned}$$

Staring at the graphs – particularly the differences in the plots - long enough quickly results in questioning the correctness of the plots; are the differences between the various plots of a particular graph fitting and within limits? Insinuating that the plots are incorrect implies that the government bond yield

[92] In none of the cases more than three government references were used. Therefore the government references selected can be seen as best choice, second best choice, and third best choice - in terms of maturity distance.

spreads are *significantly* outside acceptable boundaries – refer to Equation [34].

In addition to differences caused by specific market conditions like demand and so forth, reasons why Equation [34] may be non-zero are:

a) differences in the underlying coupons offered by the bonds,

b) non-corresponding coupon payment dates – also assuming that coupon payments are equally spaced,

c) non-identical maturity dates,

d) the number of coupons outstanding differs.

Point d) is really just the result of point c) and b).

The points above should become clear when it is considered that a difference in yields stems from a difference in price, in turn due to a difference in cash flows and due to a difference in the relevant period the cash flows should be discounted over. That a difference in cash flows (number and magnitude) and a difference in the relevant period can impact the price of an issue becomes clear when spot rates – whether calculated (market devised) or hypothetical - are used to calculate the present value of an array of cash flows; that a difference in price can impact the yield is evident when referencing the bond-yield calculation. What is more, the points above equally apply to corporate bonds.[93]

Thus, although very easy to reference, the utility of individual risk-free bonds may not be without cost – to the extent with which the afore-mentioned four

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[93] As was noted under the literature review, the yield on a corporate bond is equal to the base rate *plus* the yield premium – see for instance Equation [22]. At the moment the issue of interest is the base rate, thus the yield premium can be momentarily discarded - the corporate issue can be seen as another risk-free bond. Even after discarding the yield premium, the yield on the corporate issue will still not match that of its government reference if a price difference between the two issues exists, in turn due to a difference in cash flows and due to a difference in the relevant period the cash flows should be discounted over. To see why a price difference will still exist, continue to see the corporate issue as a risk-free bond by momentarily ignoring its yield premium. The prices of both issues – the corporate issue and its government reference - can be calculated by using the same yield rate, the ruling market risk-free rate. Alternatively, write both issues' prices out by referencing a term structure (risk-free spot rates) – see for instance Equation [22].

points are relevant.[94] Then again, it should be enquired why the referencing of individual risk-free bonds is necessary in the first place. This may be because of:

a) A lack of competencies with regards to calculating/ devising applicable forward rates – the market shorts a proper term structure[95]

b) Poor dissemination of applicable forward rates, possibly originating from a lack of transparency with regards to the calculation of forward rates – the market possesses over a term structure, but it is improperly disseminated to all market participants

In the pricing of corporate issues, the use of individual risk-free bonds may distort the underlying *single,* presiding market risk-free term structure under certain circumstances. The distortion stems from a mismatch between the corporate issue and the risk-free issue, in terms of coupon size, coupon paying dates and maturity dates.[96] The distortion is probably also amplified by the relevant period the calculation is used for – the remaining time-to-maturity.

The magnitude of the distortion can be measured by referencing a term structure – calculating and comparing the present value (and then yield) of the corporate issue and its risk-free issue selected as reference. Alternatively - and particularly in cases where a term structure is not that easily accessible - a series of historic risk-free rates can be used to simulate a term structure, to simulate the distortion in turn. As a rough indication, the distortion is expected to be comparable to the difference between the yields on two risk-free references, depending on how well matching takes place between the two risk-free references and then between the corporate issue and each of the risk-free references – refer to the graphs under APPENDIX C. The study

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[94] In cross-referencing APPENDIX C, Table 11 and Table 24 it can be seen that some of the corporate issues crosses at least point a) – a difference in coupon rate and thus coupons offered.

[95] Devising a term structure is not seen as the same as decomposing a term structure – the one is the exact opposite of the other. The latter decomposes a term structure into spot rates and future rates; the former constructs a term structure by assigning future rates.

[96] Apart from any distortion created by a mismatch between the corporate bond and the risk-free reference bond, the use of individual risk-free bonds also assumes that the presiding term structure is correctly integrated into a yield-value by the individual reference bond – calculating the reference issue's price (and then yield) through utility of the presiding term structure will match the yield offered on the particular bond. The effect of this particular assumption may of course be negligible in some cases (arguably because a properly disseminated term structure exists).

didn't attempt to quantify the magnitude of any price distortion caused this way.

Due to practicalities, the study follows the market in using government bonds as risk-free references, although this may not always be the correct method - referencing risk-free issues can't make up for any absence of or poor access to a market term structure. [It is also believed that any absence of or poor access to a term structure has other negative externalities not mentioned here.]

Risk-premium derivation in pricing corporate bonds

When visiting the yield spread plots of corporates depicted against that of potential references – as captured by the graphs under APPENDIX B – it is apparent that the yield spreads of corporate bonds differing in terms of issuer subcategories, coupon rates, time-to-maturity, and so forth do in fact differ with regards to premium demanded. What is more, it is clear that the premiums also change over time. Without speculating whether premiums are in line with market conditions, so far this reflects positively on the pricing of premiums.

It must be noted that it is not clear to what extent tax differentials exist in the market, and how (if) the market is approaching tax differentials. As indicated in a number of preceding chapters, for the purposes of analysis, an even better batch of price data might have been yield series with the tax premium removed. Similar to the argument why the risk-free rate is removed from the yield series, subtracting the tax premium would have better exposed the underlying premium attributable to factors more congruent to default risk and thus credit ratings - tax has nothing to do with ratings or their impact.

A comparison of the different yield spreads obtained from different government bond references (see APPENDIX C) draws attention to the relative stationarity of the premiums demanded. Therefore, although premiums change, it can be asked whether their movements are in order – do the premiums correctly represent market conditions at all times? In addition, in what is to be expected with regards to the relative movement of premiums over time?

It appears as if the premiums are more or less constant over the shorter period window - this may very well be appropriate, given the short period of time involved. In some cases it also appears as if the same constant movement also presides over the longer window period; whether one should expect non-constant movement over a longer period is a good question. On the one hand, one might expect the premium to trend downwards - as time passes an issue will have fewer cash-flows exposed (outstanding); it may be easier to be well-informed about the risk involved in a few cash-flows as opposed to a number of cash flows, as uncertainty *generally* decreases with time. In both cases – the short window period and the longer window period – the issue of compounding (discrete versus continuous) also plays a role.

Without insinuating that the measured premiums should in fact have been less stationary (premiums should have moved more frequently) - in light of the literature review on bond price determinants, namely default risk and systematic risk, issuer-subcategory and business-cycles, and downgrade risk, general reasons why the premiums might not have moved that frequently are listed below.

a) These risks were not present in the particular market, or irrelevant in the particular market

b) These risks were not perceived to exist by market participants and thus were not priced, or the handling of these risks was generalized (over-simplified or non-sophisticated)

Considering the mentioned risks in more depth and starting with the business cycle and issuer sub-category, a lack of price movement might mean that the business cycle did not change or that it did not impact on the default risk of bonds. Alternatively, the impact of the business cycle on issuers and thus issues was not considered and thus not priced.

With regards to default risk and systematic risk - if systematic risk is interpreted as a measure of relative public company (market) performance, and thus indicative of or at least informative about default probabilities, one would expect some movement in prices if the systematic risk of public companies did not remain constant.

Lastly, reaction towards certain market events might have played a role – negative price movements resulting from events not limited to downgrade risk might have been approached by opting to "hold on to the issue" instead of a "cutting the losses" approach.

Introducing Equation [20] to the discussion, a lack of movement is attributable to no change in forecasted recovery rates, the term structure, or periodic default probabilities.

Under section 2.2 - Determinants of Bond Prices, it was noted that by building on literature on Bond Price Determinants originating from developed markets, the assumption is made that Bond Price Determinants in developing countries are similar, albeit possibly of greater extent. It appears as if the opposite might also be true - especially if a risk factor exists, but it is not as sophisticatedly priced as would possibly have been the case in a developed market. It is also important to recall that yield data is considered and not pure price data. More frequent yield movements require more frequent price movements of a certain degree and this require a certain degree of change in risk factors known or perceived. Another point to consider is that most bonds in the sample are highly rated – i.e. of high quality – and of relatively short maturity. This should also affect pricing of these issues and relative movement of prices.

It is outside the scope of the study to investigate whether the measured price data are comprehensive; whether it is merely a very risk-free market and investors acted comprehensively or whether the market is far less risk-free and investors did or could not respond appropriately; Whether the business cycle changed around the study period; Whether investors should have responded to such a change and whether they in fact did; Whether investors responded to systematic risk changes; What kind of information investors considered when pricing and how much information was available - how quickly new information arrived; Whether any such imbalances were actually big enough to incentivize trade; Whether trade in fact did take place, but just in the dealer market and that the assumption that no price difference between the exchange market and dealer market exist is probably wrong.

7.2 The Nature of Prices around Events

Average Cross-Sectional and Series Yield Spreads

Figure 9 and Figure 10 (Figure 11 to Figure 13) delineate the average cross-sectional (series) yield spread of the study's non-callable sample and also of a non-callable corporate-bond reference sample over a [-180; 180] and [-60; 60] window period respectively. The cross-sectional average yield spread refers to the average of yield spreads across specific points of the window period – the average of the yield spreads of all observations in the sample for each point of the window period, e.g. the average of all observations' yield spread measure on the event date [0]. The average series yield spread refers to the average of an issue's yield spread series over the window period – the average of the yield spreads of each observation within the sample, e.g. the average yield spread likely to be measured for issue i over the period $[-180;180]$.

The corporate-bond reference sample is made up of the corporate bonds that were considered for the purposes of referencing at the beginning of the data analysis. The samples were not subdivided into upgrade and downgrade sub-samples, however.

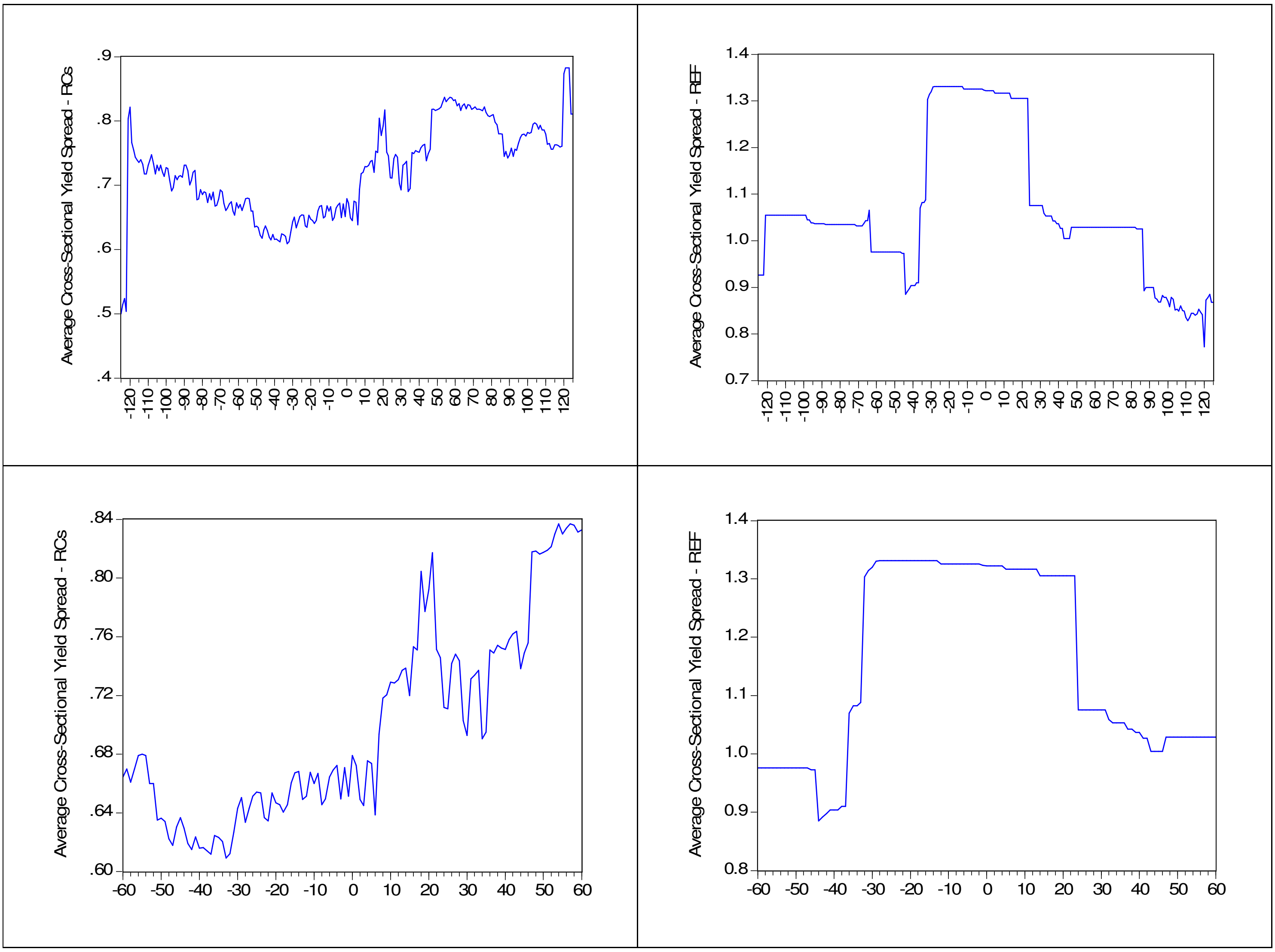

Figure 9. Average Cross-Sectional Yield Spread – [-180;180]; [-60;60]

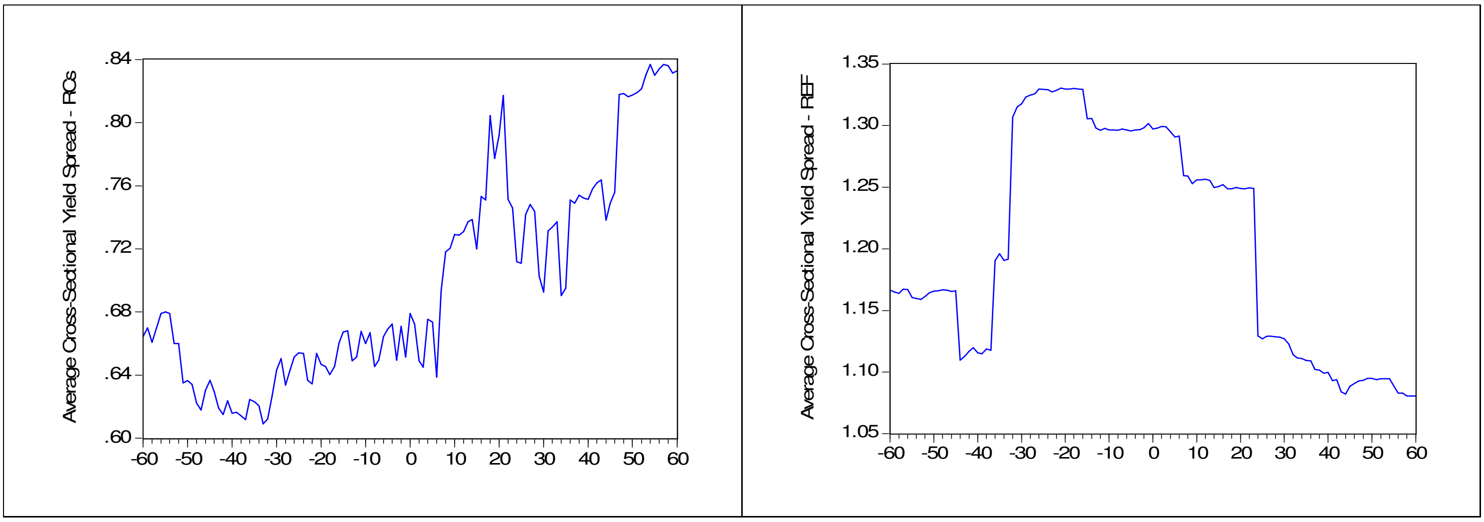

Figure 10. Average Cross-Sectional Yield Spread – less restricted reference sample

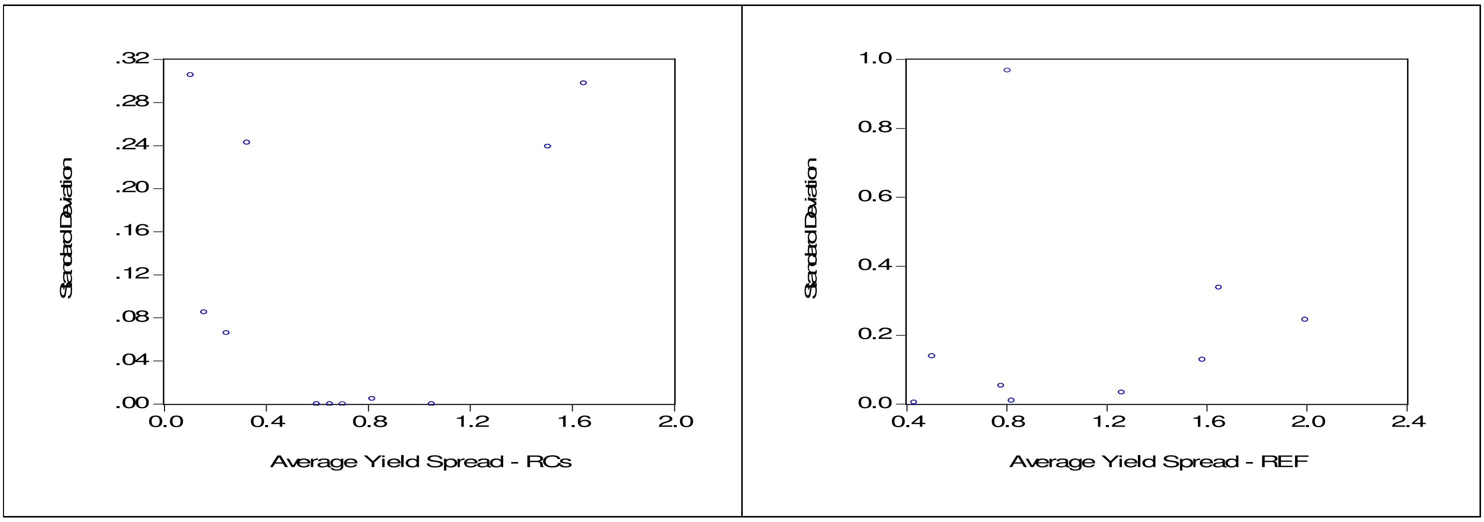

Figure 11. Average Series Yield Spread – [-180; 180]

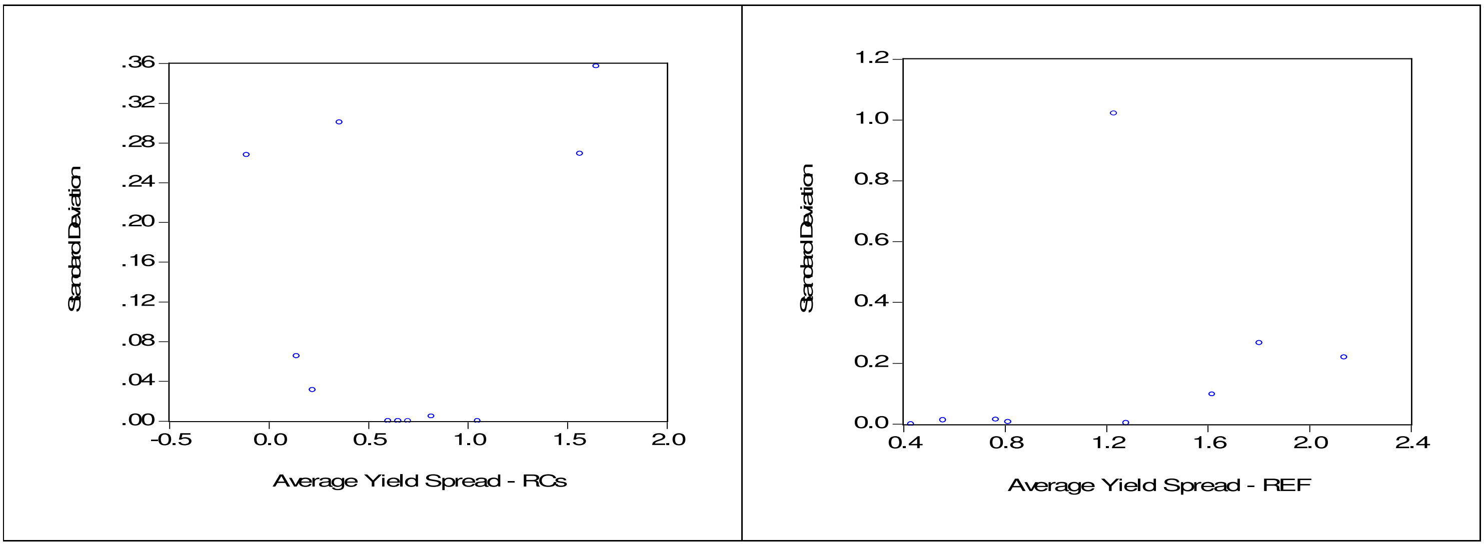

Figure 12. Average Series Yield Spread – [-60; 60]

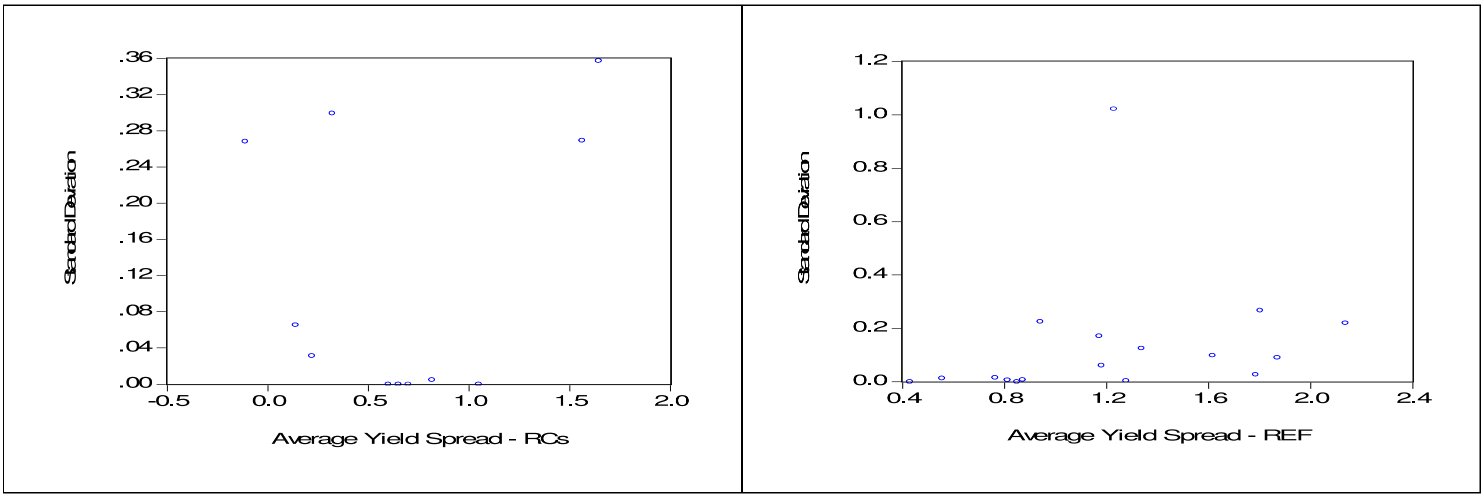

Figure 13. Average Series Yield Spread – [-60; 60]; less restricted reference sample

Given that some corporate references were considered as potential references for multiple issues under study, “overlapping” of corporate references where removed from the reference sample, by discarding the corporate reference as a potential reference for certain issues under study.[97] Otherwise it may happen that the averages calculations incorporate multiple yield spread series of the same reference bond over the same period. It is still seen as appropriate if the calculations incorporate multiple yield spread series of the same reference bond over different periods.

Considering a shorter window period - [-60; 60] - of course reduces the occurrence of overlapping, and thus results in a bigger reference sample. Figure 10 (Figure 13) depicts the average cross-sectional (series) yield spread calculated for such a reference sample over the mentioned window period.

Figure 9 to Figure 13 reflect on the context the test faces. The nature of average series yield spreads and the standard deviation thereof are certainly rough indications of the dynamics of the particular market. Based on Figure 11 to Figure 13, the statistical tests generally face yield spread series with low averages and little variation. Intuitively, one might think that it is easier to encounter significant impacts in higher average yields with greater deviation, simply because it may be easier for higher averages to house great movements than it is for lower averages, and in the hope that greater standard deviation reflects on definite and clear (discrete) price movements. If the graphs are split along the horizontal axis, a few outliers exist that generally break away from the market cluster. Unfortunately, these outliers seemingly appear in both the rating change (RC) sample and reference sample.

With regards to Figure 9 and Figure 10, evidence of price movements around event dates is certainly desirable. Ideally, a definite hump around day [0] should be apparent when compared to the reference sample’s graph, to indicate the existence of price movements not generally attributable to normal variation. Figure 9 and Figure 10 may likely suffer from small sample sizes

[97] “Overlapping” mostly occurs when two or more issues under study have event dates - and thus window periods - quite close to each other, and they share certain corporate references.

and the fact that upgrade and downgrade events were not separated into sub-samples (due to the respective sizes of these sub-samples). The graphs are nevertheless examined. Ignoring the magnitude for a moment, the graphs seem to be in direct contrast to what is desired – it appears as if the reference sample's graphs contain the mentioned hump, instead of the rating change sample.

According to the Kwiatkowski Phillips Schmidt Shin test, the reference sample and the rating change sample are both difference stationary (at the 1% level) over the long period window (see Figure 9). The same test also finds both samples difference stationary over the shorter window period; the rating change sample is difference stationary at the 5% level and the reference sample is difference stationary at the 1% level. For the shorter window period of Figure 10 the same applies; the rating change sample is difference stationary at the 5% level and the reference sample is difference stationary at the 1% level.

In applying the Phillips Perron test – with regards to Figure 9, the rating-change-sample plot does not contain a unit root over the longer window period; it is found trend stationary (at the 1% level) rather than difference stationary. The reference sample is trend stationary at the 10% level. Over the shorter window period of Figure 9, the rating change sample is difference stationary, whilst the reference sample is trend stationary at the 10% level. For the graphs of Figure 10, the rating change sample is difference stationary, whilst the reference sample is trend stationary at the 10% level.

Both tests were merely applied in an introductory capacity and should be approached accordingly. The results posted thus far already reveal the difference in the tests. A downfall of the figures are that they are unable to hint whether impacts will be economical as opposed to merely significant, and on an individual basis, how many cases of significant impacts exists - the graphs in the figures are derived from aggregates. Any humps present in the graphs may be attributable to a few economical impacts, or a number of significant impacts. The graphs can generally be improved by considering more yield spreads series, in order to improve the reference sample.

Yield Spread Changes

APPENDIX D and APPENDIX E contain daily yield spread differences and summations of these yield spread differences respectively, over both window periods. The yield spreads depicted under APPENDIX C of course serve as primary inputs to both calculations. Yield spread differences are calculated by subtracting the present day's yield spread from the previous day's yield spread; summation of yield spread differences are merely an accumulation of these differences, calculated for each day of the window period, accumulated from the starting day of the window period to that particular day.

$$\Delta YS_{it} = YS_{it} - YS_{i(t-1)} \qquad \textbf{[35]}$$

$$\sum \Delta YS_{in} = \sum_{t=1}^{n} \Delta YS_{it} \qquad \textbf{[36]}$$

Roughly speaking, the yield spread difference calculations remove an induced price series from an issue's base premium; remotely the reverse of simulations conducted by Brown and Warner (1985) and Boehmer et al (1991). The base premium is of course the yield spread value at the beginning of the window period. The summation graphs reveal the overall pattern (direction) in the induced price series.

With reference to yield spread difference graphs of the non-callable bonds under APPENDIX D, a number of issues show movement over the three month window period, as well as over the one year window period. These are [AG01 (1); FRBN01 (5); FRBN02 (75); FRBN03 (15); HAR1-A (55); HAR1-B (55)]. The maximum absolute yield spread change (bp) is indicated in brackets. Except for [SBK4 (45)], the remaining issues apparently do not even show movement over the one year window period. Furthermore, the nature of movement is totally different in the cases of [AG01; HAR1-A; HAR1-B], compared to the movement registered for [FRBN01; FRBN02; FRBN03] in that it is more distinct than continuous. Only [FRBN01; FRBN02; FRBN03; HAR1-B] show movement within the [-5; 5] and [-10; 10] sub-windows.

With reference to yield spread difference summations of the non-callable bonds captured under APPENDIX E, of all the issues that actually experience price movements over the three month window period, the movements of [AG01; HAR1-A; HAR1-B] clearly correspond with their rating change's implied direction. In the cases of [FRBN01; FRBN02; FRBN03] it is more difficult to tell. Interestingly, over the longer window period it appears as if the direction of [FRBN01; FRBN03] is opposite to that implied by the rating change. Also, [HAR1] manages to shrug off (loose) any yield spread accumulations in both its cases; in the case of [HAR1] the yield spread changes are more temporary than permanent, in contrast to the case of [AG01] for example. In addition, whilst [SBK4] shows little movement over the short window period, some negative trend seems to persist over the longer window period.

In summary, some of the issues reveal price developments over the long period window that correspond to their rating changes; whilst some show price developments that is contradictory to that implied by their rating changes. Also, in some cases the price developments are rather temporary than permanent; although movement in fact occurs - as opposed to no movement in other cases - there is little difference between the end-values and starting-values.

With reference to the yield spread change graphs of the callable bonds also contained under APPENDIX D, only [NED1 (23); SLI1 (8)] show price movements over the short window period. In addition to these issues, [NED2 (9); SLI2 (10)] at least show movements over the one year window period. [The maximum absolute yield spread change (bp) is indicated in brackets.] In all the cases, movement is rather sporadic. Only [SLI1] shows movement within the [-5; 5] or even the [-10; 10] sub-window.

With Reference to the yield spread difference summations of the callable bonds captured under APPENDIX E, [NED1; SLI1] are the only issues with price developments over the short period window. Furthermore, only the price development of [SLI1] appears with direction; the price development of [NED1] is far less distinct in direction. The direction of movement in the case of [SLI1] is opposite to that implied by the respective rating change. Over the longer window period, [NED1; NED2; SLI1; SLI2] all show price developments; those of [NED1; SLI1] contradict their rating changes, whilst those of [NED2; SLI2] support their rating changes. Over the longer period window, the price developments of [NED1; SLI1] also appear a lot more trendy as opposed to sudden interruptions to a constant series.

In offering a concluding remark, it is interesting to note that some price movements/ developments actually contradict the rating change; also, even if a price development can be ascribed to a rating change - which was never attempted in this particular section - the development may not necessarily be permanent. The analysis was of course simplified by the relative stationarity of the individual yield spreads.

Volume Data

The very nature of the market allows volume data to be considered as an additional source of information, through an investigation of volume data around event dates and over window periods of marked issues. In well traded markets, patterns in trade may be less obvious; in markets with less frequent trade, patterns may be more obvious. Furthermore, it is likely that any articulation of useful information to the market will result in increased trade, when compared to periods in which little new information was articulated to the market.

APPENDIX F contains the volume graphs of both government bonds and corporate bonds considered in the study. Particularly in the case of government bonds, some of the graphs were plotted over shorter periods if it was found that trade did not take place, needless to say that not all bonds were in issue over the entire study period. Unfortunately, volume data could not be located for all issues - whether government bond or corporate bond. It is not clear whether this is due to missing data or no data. Any interpretation of volume data offered under this section should be read bearing this in mind.

As was noted earlier on, the study clearly utilizes fairly well-traded government bonds as reference cases.

A point to note is that, according to the corporate graphs, it appears as if trade started to pick up from 2006 – for some bonds at least. Given that the study period is from late 2003 to 2007 - with most events in 2005 and prior - it may be that the study period coincides with a period in time when market coverage had been less than what it has been the last few years and probably what it is at present.

Of the non-callable bonds only [IV01] show convincing trade over its event period - although the issue never really registered a price movement or development over its event period. Of the callable bonds only [SLI1; SLI2] show convincing trade over their event periods (the same period partly due to the same issuer), with only [SLI2] registering price developments in support of the rating change. It should be remembered that only INVESTEC - issuer of [IV01] - and SANLAM LIFE INSURANCE - issuer of [SLI1] and [SLI2] - experienced rating changes post 2006.

Lastly, another important point is that, although increased trade may lead to increased liquidity, increased trade does not necessarily lead to less stationary prices in the market. Consider the cases of [IV01] and also [MTN01] – although both experience "above average" trade compared to other issues, the prices of both do not appear fundamentally different from that of other issues – see APPENDIX B, [MTN01] was considered as a potential reference for [IV01].

7.3 The Statistical Testing of Abnormal Performance

Table 21 contains the Phillips-Perron (hereafter PP) unit-root test results, as applied to the [-180; 180] window period; Table 22 contains the Kwiatkowski-Phillips-Schmidt-Shin (hereafter KPSS) stationarity test results, as applied to the [-180; 180] window period. Table 23 contains the PP unit-root test results, as applied to the [-45; 45] window period; Table 24 contains the KPSS stationarity test results, as applied to the [-45; 45] window period. For each of the tests and window periods, two model-specifications are generally considered: a constant without time-trend (results reported on the left-hand side of the tables) and a constant with time-trend (results reported on the right-hand side of the tables). The reason for this is that it cannot be said with confidence that yield spread series should follow the one or the other.

The outcomes of the tests are generally to sort issues in one of two bins – issues that accept trend-stationarity and issues that reject trend stationarity in favour of difference stationarity (a unit root is present in the series). The tests were applied to the individual yield spread series of both the non-callable sample as well as the callable bond sample; the test-results are not reported in separate tables, instead the results of the callable bonds are grouped together and highlighted.

In general, the Phillips Perron test delivers poor model fit in both window periods and under both model specifications. With the inclusion of a trend specification, the Kwiatkowski Phillips Schmidt Shin test on the other hand at least manages to achieve good model fit for both window periods. In addition, based on achieved fit, the KPSS test seems to be more apt to certain series types than the PP test; the converse is also true. It seems as if the KPSS test "handles" a sudden jump in a constant no-trend series - see for instance [AG01] and compare test results across tests - as well as any series with a visible trend - see for instance [FRBN01] and [FRBN03] - better than the PP test. The PP test on the other hand seems to handle apparent drift better than the KPSS test - see for instance [FRBN02]. This may very well be due to the underlying difference in null-hypothesis specification of the two tests.

Although results are posted for the one year window period, this is merely to complement the shorter window period results; the longer window period results will not be taken into consideration when forming conclusions in the end. Reporting on the various test results in general: for the non-callable sample, a number of issues are difference stationary and thus experienced significant impacts - [AG01; HAR1-A; HAR1-B; FRBN02; FRBN03]; in the case of the callable sample, [NED1; SLI1] are difference stationary. The results are discussed in more depth later-on.

Table 21. Phillips Perron Test Results – [-180; 180] window period

Issue	PP: Constant | H_0 : Unit Root			PP: Constant + Trend | H_0 : Unit Root			
	Coefficient	R^2	Test-Statistic	Coefficient	Trend-Coefficient	R^2	Test-Statistic
AG01	-0.009615	0.001293	-1.144284°	-0.028012	1.45E-06	0.004839	1.779533°
FRBN01	-0.000751	-0.004239	0.301063°	-0.031543	3.85E-05	0.018240	-1.61121°
FRBN02	-0.150525	0.065005	-3.734965°	-0.152371	9.56E-05	0.060647	-3.780359**
FRBN03	-0.030489	0.009136	-1.339157°	-0.095218	0.000101	0.054479	-3.607634**
HAR1	-0.013899	0.002802	-1.504692°	-0.009157	-3.32E-05	0.001858	-1.061248°
HAR1	-0.013625	0.001840	-1.259759°	-0.015188	1.30E-05	-0.001997	-1.260019°
IV01	-	-	-	-	-	-	-
SBK4	-0.006339	-0.005619	-0.162540°	-0.025406	-4.18E-05	0.006781	-0.887548°
SBN6	-	-	-	-	-	-	-
SBN7	-	-	-	-	-	-	-
SBN8	-	-	-	-	-	-	-
NED1	-0.084203	0.043675	-2.688781***	-0.120391	-5.71E-05	0.053486	-3.130212°
NED2	-0.002941	-0.004640	-0.317405°	-0.036285	3.47E-05	0.013562	-2.011396°
SBN2	-	-	-	-	-	-	-
SBN3	-	-	-	-	-	-	-
SBN4	-	-	-	-	-	-	-
SBN5	-	-	-	-	-	-	-
SBN9	-	-	-	-	-	-	-
SLI1	-0.014479	0.009942	-1.728920°	-0.041541	3.83E-05	0.018159	-2.241802°
SLI2	-0.020408	0.012346	-2.012461°	-0.024660	-3.23E-06	0.009050	-1.755002°

*	Significant at 1% level	***	Significant at 10% level
**	Significant at 5% level	°	Null not rejected

Table 22. Kwiatkowski Phillips Schmidt Shin Test Results – [-180; 180] window period

Issue	KPSS: Constant | H_0 : Trend-Stationary			KPSS: Constant + Trend | H_0 : Trend-Stationary			
	Coefficient	R²	Test-Statistic	Coefficient	Trend-Coefficient	R²	Test-Statistic
AG01	-	-0.000000	1.699665*	-	5.66E-06	0.722697	0.243932*
FRBN01	-	0.000000	1.336684*	-	0.000645	0.517749	0.366628*
FRBN02	-	0.000000	0.194882°	-	0.000512	0.005807	0.144893***
FRBN03	-	0.000000	1.446197*	-	0.000868	0.561243	0.202213**
HAR1	-	-0.000000	0.757330*	-	0.001400	0.194494	0.249296*
HAR1	-	0.000000	0.790395*	-	0.001788	0.205406	0.238360*
IV01	-	-1.419698	5.978730*	-	3.20E-17	-7.190739	5.076173*
SBK4	-	0.000000	0.475237**	-	-0.000410	0.185448	0.182460**
SBN6	-	-0.641026	5.000881*	-	-1.72E-17	-2.412947	5.716714*
SBN7	-	-0.339367	5.741605*	-	1.15E-17	-1.194053	4.905986*
SBN8	-	-0.036437	2.418711*	-	8.59E-18	-0.445484	3.509186*
NED1	-	0.000000	0.968501*	-	-0.000579	0.365492	0.408272*
NED2	-	-0.000000	1.553236*	-	0.000792	0.753907	0.367117*
SBN2	-	-0.339367	5.741605*	-	1.15E-17	-1.194053	4.905986*
SBN3	-	-0.641026	5.000881*	-	-1.72E-17	-2.412947	5.716714*
SBN4	-	-0.339367	5.741605*	-	1.15E-17	-1.194053	4.905986*
SBN5	-	-0.036437	2.418711*	-	8.59E-18	-0.445484	3.509186*
SBN9	-	-0.641026	5.000881*	-	-1.72E-17	-2.412947	5.716714*
SLI1	-	0.000000	1.562006*	-	0.001127	0.798218	0.308196*
SLI2	-	0.000000	1.104989*	-	-0.000352	0.0460444	0.361827*

*	Significant at 1% level	***	Significant at 10% level
**	Significant at 5% level	°	Null not rejected

Table 23. Phillips Perron Test Results – [-45; 45] window period

Issue	PP: Constant | H_0 : Unit Root			PP: Constant + Trend | H_0 : Unit Root			
	Coefficient	R^2	Test-Statistic	Coefficient	Trend-Coefficient	R^2	Test-Statistic
AG01	-0.111111	0.080460	-2.479899°	-0.120505	3.03E-06	0.065603	-2.127782°
FRBN01	-0.108879	0.039591	-1.925279°	-0.228956	-0.000270	0.136857	-3.196773***
FRBN02	-0.207774	0.080609	-2.484535°	-0.203346	-0.000325	0.065765	-2.283490°
FRBN03	-0.105688	0.048821	-2.025095°	-0.184912	-0.000443	0.091501	-2.790943°
HAR1	-0.066667	0.036066	-1.820952°	-0.088434	3.31E-05	0.024873	-1.632453°
HAR1	0.069715	0.005876	-1.158790°	-0.097168	0.001330	0.010349	-1.572252°
IV01	-	-	-	-	-	-	-
SBK4	-	-	-	-	-	-	-
SBN6	-	-	-	-	-	-	-
SBN7	-	-	-	-	-	-	-
SBN8	-	-	-	-	-	-	-
NED1	-0.201362	0.072987	-2.420369°	-0.346182	-0.000557	0.140223	-3.521230**
NED2	-	-	-	-	-	-	-
SBN2	-	-	-	-	-	-	-
SBN3	-	-	-	-	-	-	-
SBN4	-	-	-	-	-	-	-
SBN5	-	-	-	-	-	-	-
SBN9	-	-	-	-	-	-	-
SLI1	-0.036331	-0.002660	-0.919481°	-0.207131	0.000261	0.072168	-2.552084°
SLI2	-	-	-	-	-	-	-

* Significant at 1% level　　*** Significant at 10% level

** Significant at 5% level　　° Null not rejected

Table 24. Kwiatkowski Phillips Schmidt Shin Test Results – [-45; 45] window period

Issue	KPSS: Constant | H_0 : Trend-Stationary				KPSS: Constant + Trend | H_0 : Trend-Stationary			
	Coefficient	R^2	Test-Statistic		Coefficient	Trend-Coefficient	R^2	Test-Statistic
AG01	-	-0.000000	0.471296**		-	0.000103	0.314732	0.188018**
FRBN01	-	0.000000	0.619809**		-	-0.000929	0.444213	0.114587°
FRBN02	-	0.000000	0.219008°		-	0.000286	0.001777	0.180737**
FRBN03	-	0.00000	0.617300**		-	-0.002266	0.412421	0.150759**
HAR1	-	-0.000000	0.633311**		-	0.000781	0.502029	0.202803**
HAR1	-	0.000000	0.900503*		-	0.016611	0.773487	0.121145***
IV01	-	-0.041382	0.202258°		-	3.17E-17	-0.270706	2.139451*
SBK4	-	-	3.246377*		-	1.04E-17	-	1.917869*
SBN6	-	-0.030518	0.311743°		-	-1.04E-17	-0.052779	1.142718*
SBN7	-	-0.068804	2.144276*		-	1.04E-17	-0.236453	2.255127*
SBN8	-	-0.092585	0.785953*		-	-4.16E-17	-0.562106	2.069620*
NED1	-	0.000000	0.685498**		-	-0.001466	0.370651	0.053544°
NED2	-	-0.000091	0.217574°		-	-2.09E-17	-0.114787	0.843106*
SBN2	-	-0.068804	2.144276*		-	1.04E-17	-0.236453	2.255127*
SBN3	-	-0.030518	0.311743°		-	-1.04E-17	-0.052779	1.142718*
SBN4	-	-0.068804	2.144276*		-	1.04E-17	-0.236453	2.255127*
SBN5	-	-0.092585	0.785953*		-	-4.16E-17	-0.562106	2.069620*
SBN9	-	-0.030518	0.311743°		-	-1.04E-17	-0.052779	1.142718*
SLI1	-	0.000000	0.849236*		-	0.001219	0.781094	0.081805°
SLI2	-	-0.077796	1.098091*		-	3.06E-17	-0.807506	2.268161*

*	Significant at 1% level	***	Significant at 10% level
**	Significant at 5% level	°	Null not rejected

With reference to Table 21 and Table 23, the PP test simply could not be applied to a number of issues which all had extremely stationary series. These issues were immediately taken as trend stationary then. Looking up the KPSS test results of these issues under Table 22 and Table 24, the KPSS test could be applied to these issues, but the results posted for these issues differ from than of other the issues – in general these issues carry negative non-zero R^2 values. On these grounds, the KPSS results for these issues are ignored and the issues are confirmed as trend stationary.

Taking Table 21 and Table 22 as examples, in some cases the change in model specification from no-trend to trend is accomplished by a change in the outcome, i.e. the change in model-specification alters whether the series is found to be trend stationary or difference stationary. This in not the case for all issues though. Nevertheless, this occurrence of course calls for some method to consolidate the outcomes of the different model specifications. Under Table 21 for instance, this dilemma only occurs for [FRBN02; FRBN03]. In the case of [FRBN03] some trend is rather apparent, although this can not be said about [FRBN02]. Not surprisingly, the inclusion of a trend specification increases fit in the case of [FRBN03], but not in the case of [FRBN02].

Therefore, during consolidation of results, the decision regarding which result set to adopt is based on achieved fit, on the condition that the respective graph concurs that it is sensible to do so. Also, the KPSS test should actually take precedence, given that its null-hypothesis specification is that of trend stationarity.

[-180; 180] Window Period

For the sample of non-callable issues, a number of issues are difference stationary according to the PP test (Table 21); these are: [AG01; FRBN01; HAR1-A; HAR1-B; SBK4]. In the cases of [FRBN02] and [FRBN03] the outcome is complicated by the model specification. Ultimately, in the case of [FRBN02] the null hypothesis of difference stationarity is accepted, and in the case of [FRBN03] trend stationarity at the 5% level.

For the sample of callable issues, the majority of issues are trend stationary, with the exclusion of [NED2; SLI1; SLI2]. The case of [NED1] is complicated by the model specification; in the end the null-hypothesis of difference stationarity is accepted.

In considering the KPSS test results (Table 22), the non-callable issues are predominantly difference stationary as opposed to trend stationary – the significance levels can be found under the table and are not reported here. The exclusion is of course [FRBN02], which in this case is a very difficult call: the graph may or may not insinuate the presence of a trend; the trend coefficient is also relatively small. In the end, difference stationarity at the 10% level is accepted. [With regards to some of the other issues under Table 22, recall that issues with negative, non-zero R^2 values are automatically designated as trend stationary.]

For the sample of callable issues and the KPSS test, difference stationarity dominates at the 1% level. There is also no difference between the results for callable bonds posted under Table 21 and Table 22.

In consolidating the results of non-callable issues posted under Table 21 and Table 22, the results only differ in the case of [FRBN03] – according to the PP test results, difference stationarity should be adopted; according to the KPSS test results, trend stationarity should be adopted. Given that the issue has a clear trend to it, that the KPSS model achieves greater fit, and that the KPSS test enjoys preference, trend stationarity is accepted. In conclusion, the following non-callable issues are thus difference stationary over the one year window period: [AG01; FRBN01; FRBN02; HAR1-A; HAR1-B; SBK4]. The following callable issues are difference stationary over the one year window period: [NED1; NED2; SLI1; SLI2]

[-45; 45] Window Period

In the case of the non-callable issues, the PP test (Table 23) indicates that [AG01; FRBN02; FRBN03; HAR1-A; HAR1-B] are all difference stationary. The case of [FRBN01] is complicated by the model specification; in the end trend stationarity is accepted at the 10% level.

For the callable bonds, the majority of issues are trend stationary according to the PP test (Table 23), with the exception of [NED1; SLI1]. The case of [NED1] is complicated by the model specification. [NED1] does not appear to contain a trend over the short window period. Thus, although the inclusion of a trend specification improves fit, the no-trend specification results are adopted and the null hypothesis of difference stationary is accepted.

[With reference to Table 24, recall that issues with negative, non-zero R^2 values are automatically designated as trend stationary.] For the non-callable issues, the majority of issues are difference stationary, with the exclusion of [FRBN01] and [FRBN02]. The cases of [FRBN01] and [FRBN02] are complicated by the model specification, but in the end the null hypothesis of trend stationarity is accepted for [FRBN01] and difference stationarity at the 5% level in the case of [FRBN02].

In the case of the callable issues, the majority of issues are trend stationary, with the exclusion of [NED1; SLI1]. Both cases are complicated by the model specification. [SLI1] does reveal a trend and in the end the null hypothesis of trend stationarity is accepted; [NED1] does not reveal a trend and in the end difference stationarity at the 5% level is accepted.

In consolidating the results, for the non-callable issues, [AG01; FRBN02; FRBN03; HAR1-A; HAR1-B] are seen as difference stationary; for the callable issues, only [NED1] is seen as difference stationary.

Concluding Remarks

It was previously mentioned that the longer window period's results will not be considered in the very end. In the case of non-callable issues, the finding of difference stationarity implies that a significant impact occurred. This is of course conditional on the power of the test, whether the direction of movement is actually in the correct direction, and whether contamination can't be proven.

In the case of callable bonds, it is a bit more complicated in that the occurrence of a movement can also be ascribed to the issue's call option.

Nevertheless, cases where no movement could be found already count as significant evidence; because of the call option, it is not possible to conclude cases with evident movement in the correct direction[98], but cases with no evident movement or movement in the incorrect direction can in fact be concluded. This will be the approach taken by this study.

Recapping - for the callable issues only [NED1] and [SLI1] measured movement over the shorter window period. In the case of [SLI1], the direction of movement is in fact opposite to that implied by the rating change. It also does not appear as if the rating change worked in on this movement by "slowing it down".

For the non-callable issues, [AG01; FRBN01; FRBN02; FRBN03; HAR1-A; HAR1-B] all experienced movement over the shorter window period. Of all the mentioned issues, only [FRBN01] tests trend-stationary - [FRBN01] doesn't appear to be significantly impacted by the rating change. The direction of [AG01; HAR1-A; HAR1-B] correspond to the direction implied by the rating change. In considering the test results posted for [FRBN01; FRBN02; FRBN03] over the shorter window period, it can be speculated that [FRBN01] was trending downwards without "interference"; [FRBN02] was trending upwards, but changed course around day [22], thereby prompting the non-stationary result; similarly [FRBN03] was trending downwards, but changed course around possibly the same day (date). Also note the overall direction in movement of [FRBN03] over its longer window period.

Based on this, the direction of movement of (only) [FRBN03] is in contrast to that implied by the rating change. The issue of contamination is thus crucial in the cases of [AG01; HAR1-A; HAR1-B; FRBN02] in order to sustain that rating changes significantly impacted the bond prices of these issues.

[98] Cases with evident movement in the correct direction can be due to the rating change or due to the call option.

Power of the Test

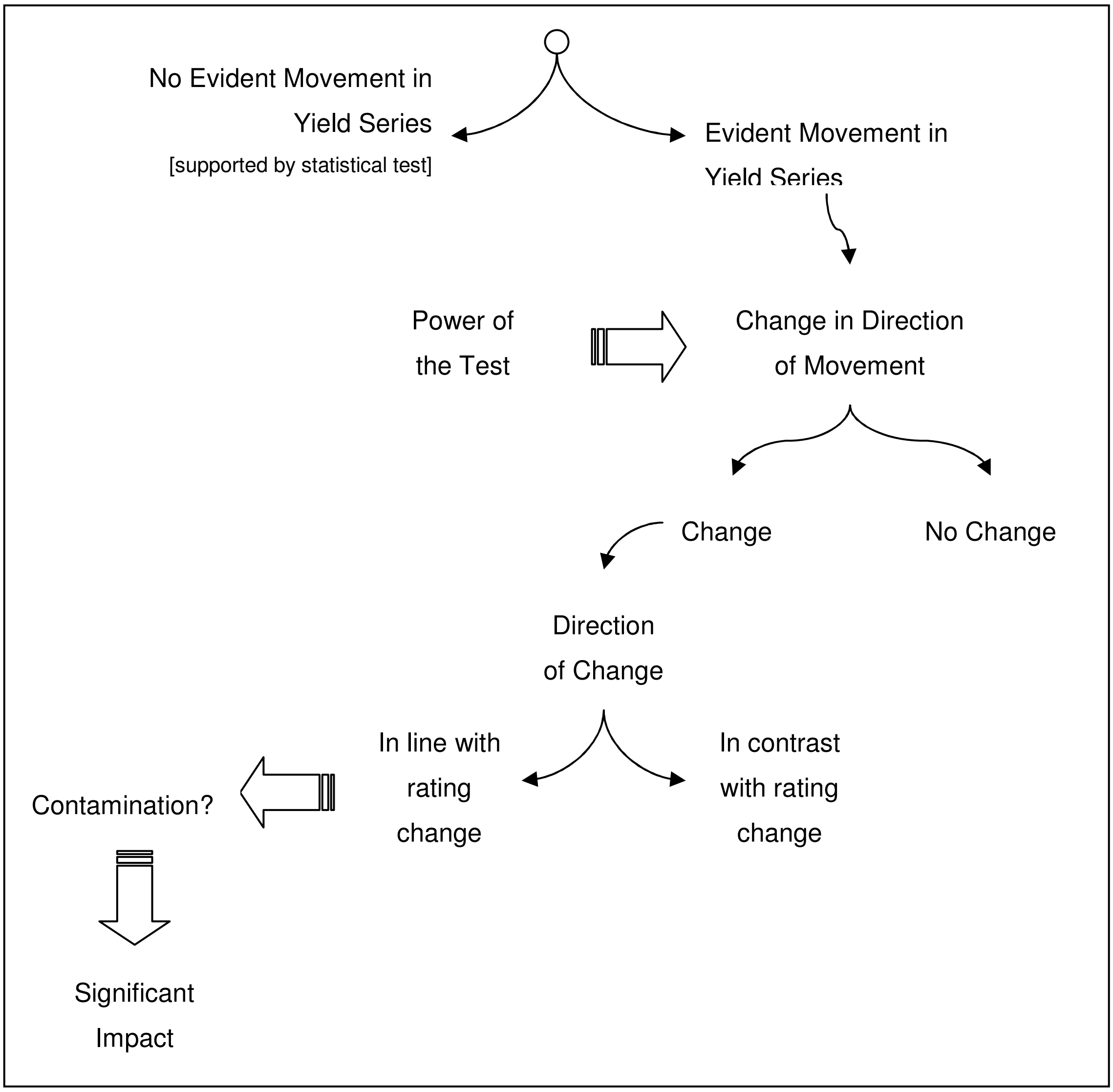

Figure 14. Underlying Logic followed during Analysis

Figure 14 offers an elementary outline of the logic followed thus far during the analysis of corporate yield spreads. The figure also outlines how the power of the statistical tests can potentially impact results. It should of course be asked whether the statistical tests utilized in the study are the perfect means of ascertaining whether any abnormal performance measurements are in fact significant – whether significant price impacts actually occurred. Should the fact that not all cases (issues) realized a decent level of model fit raise concern?

In addressing the power of the tests, one way to do so may be to reverse the tests in order to inspect how the graphs were eventually fitted by the tests' models.

In addition, the approach of Boehmer et al (1991) and Brown and Warner (1985) for instance may be followed – to run simulations whereby abnormal performance is induced in ordinary price data. As in Brown and Warner (1985) and Boehmer et al (1991), the tests should be applied to a number of ordinary base series, both with and without any induced abnormal performance, in order to note the frequency of type I and type II errors and thus the tests' performance. What would be particularly interesting to note is the level of induction required to cause the two tests to reject their separate null hypotheses. However, to commence with any such simulation some agreement must be reached in terms of the "ordinary" base series to use. Secondly, certain practicalities should also be considered in terms of the abnormal performance to be induced.

With regards to the base series, the study came across both a constant series and a linear trend during analysis. What is more, additional bases series may be obtained by considering the yield spread series derived from second-best government bond choices as risk-free references; these series were not that stationary in nature and may even introduce some variation and non-linearity. This would of course complicate the matter, but at the same time reflect on the power of the tests in an insightful manner.

With regards to the abnormal performance to be induced - in referencing the yield spread difference graphs, the most simplistic case seems to be a single, sudden shock, with immediate return to normality. As was mentioned under the Methodology chapter, Boehmer et al (1991) considered the abnormal performance function as a normal distribution with a certain mean, together with a certain specified variance (zero and non-zero). Up to this point, only abnormal performance in the form of a single shock has been considered. Some of the yield spread difference graphs actually contradict this assessment. Whether this should be seen as the occurrence of increased variance around the event date is a good question.

In some cases the relative position of the shock – the time the shock occurred - seemingly also influenced the results. This is understandable when considering that the position of the shock can potentially disrupt the formation of a trend, thereby impacting results. This is similar in nature to the simulation of event date uncertainty (see Brown and Warner 1980). The window period specification is clearly important.

Equation [6] and Equation [20] can also be consulted. Both offer insights on the ordinary base series and the abnormal performance to induce. Equation [20] relates to Equation [6], and both contain three sets of variables: recovery rates, periodic default probabilities, and the term structure. Changing the three sets of variables will change both Equation [20] and Equation [6].

Given that the term structure is probably not under the sole discretion of agencies, its effect should be removed when abnormal performance is isolated and measured. Already the nature of the base series depends on the relative maturity of issues to be used during simulation, and the foreseeable term structure; various base series can already be constructed by considering a number of maturities and historic term structures and letting these cases "run their length" – letting the cases retire – according to Equation [6].

According to Equation [6] and Equation [20], Abnormal Performance is nothing more than a mere induction or change to the underlying variables' values - abnormal performance can be induced by changing the base series' recovery rates and periodic default probabilities in various (patterned) ways. In essence, the power of the test becomes a simulation of the test's sensitivity to different maturities, term structure plots, changes in recovery rates, and changes in periodic default probabilities.

Actual testing of the power of the test is essentially a research work on its own, and will not be conducted in this study.

7.4 Contamination

Table 25. Rating Histories of Issues prior to Event Dates

Issuer	Event Date	Rating Watch	Rating Outlook
ANGLOGOLD ASHANTI LTD	(↓) 2005/11/28	-	(↓) 2004/09/16 (↕) 2004/03/30
HARMONY GOLD MINING COMPANY	(↓) 2005/05/25 (↓) 2004/08/17 (↑) 2002/05/30	(↕) 2005/04/29 (↑) 2004/10/19	(↓) 2004/08/17 (↓) 2004/03/30
FIRSTRAND BANK LTD	(↑) 2005/12/08	-	-
INVESTEC BANK LTD	(↑) 2007/12/11	-	(↕) 2006/12/11
STANDARD BANK OF SOUTH AFRICA LTD	(↑) 2004/06/09		(↕) 2004/03/30
NEDBANK LTD	(↓) 2003/12/24	-	-
SANLAM LIFE INSURANCE LTD	(↑) 2007/04/11	-	(↑) 2006/06/28-
	(↓) Downgrade (↑) Upgrade	(↓) Negative (↑) Positive (↕) Evolving	(↓) Negative (↑) Positive (↕) Evolving

Were rating-change announcements "deflated" by preceding warnings?

Table 25 depicts the rating histories of the issuers under study prior to their event dates. In the table, the histories of callable-bond issuers are grouped together and highlighted; STANDARD BANK is of course an issuer of both.

Given that this mentality has been followed by previous research, it may be appropriate to reason that events that were preceded by some warning from the side of the agency are less likely to experience a significant price impact –

a rating change preceded by a warning of some kind may be less of a surprise. It may be that investors have already reacted to warnings, and therefore do not see the need to react to the actual rating change itself.

In inquiring whether warnings deflated rating changes, it is helpful to distinguish between rating changes that were preceded by warnings and rating changes that were not preceded by warnings. No deflation is of course possible in cases without any warnings. In cases where a warning indeed preceded the rating change, no deflation, partial deflation or full deflation is possible.

Should no price reaction occur around a rating change preceded by a warning, it may be that:

a) The rating didn't contain any Private Information over and above that of the warning. The market likely responded to the warning, but not to the rating change. Therefore the warning is to blame for full deflation

b) Neither the warning nor rating change actually contained Private Information – the market didn't respond to either the rating warning or the rating change; no deflation occurred

Should a price reaction occur around a rating change preceded by a warning, it may be that

a) The rating change contained Private Information, although the warning didn't. The market did not respond to the warning, but responded to the rating change – the warning thus could not have deflated reaction to the rating change

b) The market did respond to the warning and the rating change – both warning and rating contained Private Information, either completely new (separate) Private Information or only partially new (separate) Private Information. Partial deflation or No deflation is thus possible

c) The market did not respond to the rating change and the warning, but responded to the distribution of additional information. No deflation by the warning could thus have occurred

d) The market did not respond to the rating change, but responded to the warning and the distribution of additional information. Full deflation by the warning could thus have occurred

These conditions are shown in Table 26.

Table 26. Rating Changes and Prior Warnings

<table>
<tr><th colspan="3">Price Movement around Rating Change</th><th>No Price Movement around Rating Change</th><th></th><th></th></tr>
<tr><td colspan="4">Deflation by Warning not Possible</td><td colspan="2">No Warning</td></tr>
<tr><td colspan="4">Deflation by Warning not Possible</td><td>No Market Reaction to Warning</td><td rowspan="2">Warning</td></tr>
<tr><td>No-Deflation</td><td>Partial-Deflation</td><td>Full-Deflation</td><td>Full-Deflation</td><td>Market Reaction to Warning</td></tr>
</table>

Refer to Section 2.4.1: Watchlistings. Note the number of evolving outlooks under Table 25 – it is not clear whether an evolving outlook can deflate a rating change as much as an outlook that has a similar or opposite direction to that of previous ratings. Only HARMONY has rating outlooks in conjunction with rating warnings. Furthermore, HARMONY is also the only case where an outlook was posted with the direction of the outlook different to that of past ratings.

No form of warning - whether a rating outlook or a rating warning - preceded the rating changes of FIRSTRAND BANK and NEDBANK (callable vanilla issuer). In these cases it is therefore impossible to attribute any potential lack of price movements to the fact that warnings preceded these events.

The rating changes of a number of non-callable issuers - ANGLOGOLD ASHANTI, HARMONY GOLD MINING COMPANY, INVESTEC, and STANDARD BANK - were in deed preceded by some warning, albeit to different “degrees”. ANGLOGOLD ASHANTI was on negative outlook prior to its downgrade, but for quite some time (more than a year); also, no rating watch was announced prior to the downgrade event. In the case of HARMONY, a negative outlook was posted within six months of the first rating downgrade and HARMONY remained on negative outlook prior to the second downgrade. An evolving rating-watch was issued a month or so before the second downgrade event. INVESTEC received an evolving outlook one year prior to its upgrade. STANDARD BANK received an evolving outlook just over three months prior to its upgrade. The rating change of SANLAM LIFE INSURANCE - the only remaining issuer and a callable vanilla issuer - was preceded by a warning; a positive outlook was posted about nine months prior to the actual rating change event.

ANGLOGOLD ASHANTI, HARMONY GOLD MINING COMPANY, and NEDBANK (one of its issues) did measure price movements around their rating changes, and in these cases the rating changes were preceded by warnings. It is outside the scope of this study to examine whether the market actually responded to these warnings. Later-on the study does report whether contamination occurred. In these cases it will thus be more difficult to tell whether the warnings impacted price-reactions to ratings.

INVESTEC, STANDARD BANK and NEDBANK (one of its issues) did not measure price movements around their rating changes; in these cases the rating changes were preceded by warnings. It is outside the scope of this study to examine whether the market actually responded to the warnings. It will thus not be possible to tell whether full or no deflation occurred.

In any case, note how difficult it is to discern between partial deflation and no deflation, should a rating be preceded by a warning and it is found that the market responded to both.

Were measured price movements contaminated by the simultaneous occurrence of additional information?

In order to assess whether the market received additional information over and above the ratings – whether the measured price movements of some of the cases could also have been the result of additional information other than rating-based information - The Business Day database was searched over the short window period of each rating change. The paper is taken as a representative source; it is available online and is historically the country's first mainstream business daily, dating back to 1986.

Kicking of with the callable issuers, no related news articles could be found for SANLAM LIFE INSURANCE over the course of its window period. The occurrence of a price movement in the yield series of one of its issues [SLI1] is thus probably due to the call option, given that it is likely not contaminated, of opposite direction than that implied by the rating change, and trend-stationary implying that the rating change did not work in on the movement.

With NEDBANK two articles surfaced, of which one is outlined below. Particular about the article is that it greatly amalgamates news regarding recent steps taken by NEDBANK in its turn-around challenge. In particular the article mentions that NEDBANK put out a (not to optimistic) ten month trading statement on November 17th, 2003, that it raised R2bn tier two capital on December, 22nd 2003, that it is in the process of a rights issue in order to get its tier I and tier II capital right and to repay R2bn its parent company lent it, and that it posted a (huge) loss under its financial results it recently released just prior to the news article (in the beginning of the 2004). Other articles report on changes in leadership, and so forth.

When exactly these information became known to the market is not clear in all cases; it does not seem if the articles punctually coincide with the price movements measured for one of two NEDBANK issues – [NED1]. A difference between the two mentioned issues is that the issue measuring price movements is a subordinated issue. It is again highly likely that the measured price movement for (only) one of the two issues is due to the call option - although the measured price movement of [NED1] is not trend stationary (thereby indicating impact), and contamination seems unlikely, the impact of the call option cannot be ignored.

NEDCOR is planning on getting back to basics, says its CEO	David Williams	2004/02/24

Moving on to issuers of non-callable bonds, the only real article published within its window period that could have impacted on FIRSTRAND BANK was an article on the general challenges the company faced at that time going forward, as perceived by its CE. In the case of FIRSTRAND BANK, it is also difficult to link any distinct price movement to a specific date, thereby making it difficult to link price movements to either additional news or the rating event itself. It must be pointed out that one of the FIRSTRAND BANK issues [FRBN02] included in the study was about two months away from maturity when the rating event took place. Without inferring that this affected the other two issues included in the study as well, this fact must have affected the yield series of the particular issue.

In the case of ANGLOGOLD several articles surfaced that date back to its window period; only two articles are captured below. The articles predominantly focused on Anglo American's announcement to sell its major stake in ANGLOGOLD, as well as earnings posted for that quarter. What is more, the yield spread change measured for ANGLOGOLD coincides (perfectly) with the announcement made by Anglo American.

Key Features of Anglo's Restructuring	-	2005/10/27
Smaller Anglo stake no worry for AngloGold	Charlotte Mathews	2005/10/27

In the case of the first HARMONY rating event a number of articles from the corresponding window period surfaced. The core issues the articles reported on can be summarized as: a) Harmony's hostile bid for its bigger rival, Gold Fields (bid announced on October, 18th 2004) b) job losses and concerns over job losses at Harmony c) very related to the previous point – the tough conditions Harmony faced. Some of the articles are captured below.

Thousands of jobs on the line at Harmony	John Fraser	2004/09/14
Harmony in hostile bid for rival Gold Fields	John Fraser	2004/10/18

What is important about the first article is that it also reports on a previous job cut announcement that took place on October, 9th 2004. It appears as if the market responded to these two job-related announcements – both coincide with the price developments of the first Harmony case. The second HARMONY event is examined next.

Strong rand sinks gold output to 1931 level	John Fraser	2005/04/12
Harmony's restructuring grinds up even more jobs	Neels Blom	2005/05/06
Gold Fields weighs strategy as dust settles on Harmony bid	John Fraser	2005/05/24
Gold Fields declines as Harmony sells 6% stake	-	2005/06/03
Norilsk charting route to the top of the gold game	Greg Walters	2005/06/22
Harmony bullish on deal to save Free State jobs	John Fraser	2005/06/23
Harmony obliged to buy back bond issue	Stewart Bailey	2005/07/01

Above, some of the news articles from the second HARMONY window period are shown. The first article noted a warning issued by the Chamber of Mines chief economist that the gold sector's decline could accelerate over certain reasons. The second article reflected on problematic wage negotiations that were affecting Harmony. The third article noted that the Harmony hostile bid for Gold Fields had collapsed. The fourth article relayed that Harmony had sold a certain percentage of its shares in Gold Fields (at a discount). The fifth article reflected positively on Norilsk and its relations with Gold Fields (at the time, Norilsk was a prominent potential buyer of (the remaining) shares Harmony held in Gold Fields). The sixth article reported on union negotiations were gripping Harmony and its restructuring, as well as an agreement by unions to implement "continuous operations". The last article reflected that Harmony had bought back a quarter of its issued bond. Without alleging direct connections, all the listed news articles coincide with the yield spread changes reported for the second Harmony window period.

Although no price movements were measured for issues of STANDARD BANK over its short window period, the STANDARD BANK window period was nevertheless searched. Two articles surfaced that were seen as particularly distinct; the articles are shown below. The first reported on expected earnings of good nature, and the second on the bank's intention to raise funds through the issue of preference shares. It is not investigated exactly when the initial intention to issue preference shares were reported to the market and whether this coincides with yield spread changes over the longer window period.

STANDARD seeks support to raise R2bn	Stephen Gunnion	2004/06/01
STANDARD BANK upbeat on targets	Stephen Gunnion	2004/05/20

The bond-issue of INVESTEC also did not reveal price movements over its window period. Nevertheless, the window period was searched for news articles. A few articles did surface, generally reporting on upbeat results.

In conclusion, the issue of contamination is rather irrelevant in the cases of INVESTEC and STANDARD BANK (no price movements). It is more difficult to prove contamination in the cases of SANLAM LIFE INSURANCE, FIRSTRAND BANK, and NEDBANK (no news articles, or it is more difficult to clearly link news articles to price movements). Lastly, it appears as if the price movements of ANGLOGOLD ASHANTI and HARMONY are contaminated (news articles punctually coincide with price movements).

The origin of rating warnings and rating changes

Already noted, Dynkin et al (2002) note that disappointing earnings, a large equity buy-back, a planned change in financial leverage, a merger announcement, or a rating action are all examples of developments that increase the market's perception of the probability of downgrade…

Hypothetically, although contamination is normally used to refute any linkage between price movements and rating changes, by examining additional information over the chosen window period, it may very well be applied to allude to possible reasons for the occurrence of a rating warning/ change in the first place; whether the rating warning/ change contained "new" information or not. Trivially, reports on INVESTEC and STANDARD BANK under the previous sub-section are examples of this approach.

A further, albeit more complicated extension would be to even bring into question (changes in) financial results posted for these issuers amidst their rating changes, this was not considered in this study though. Previous researches have conducted similar inquiries; these inquiries of course utilize a totally different methodology and will not be attempted here.

This section again reverts to the nature of Private Information. As opposed to merely asking whether ratings contain private information, this section outlines that it can also be asked what kinds of information will count as Private Information. As a trivial case and hypothetical example: agencies can collect information on business cycle conditions, so can investors; agencies may be able to gain access to companies' future forecasts and related data, investors not. Investors may outsource information collection to rating agencies because of economies; investors may wish to collect information themselves because information collection competencies provide competitive advantage.

7.5 The Market Vantage-Point

In moving towards the end of the Empirical Analysis and Results chapter it must be said that the study faced many choices with regards to its design. For instance, there was the choice between yields data and daily returns data. Also, there was the choice between the utility of risk-free bonds and the utility of spot rates, derived from a term structure. Some of these choices were really just a question of what was practical. In addition, the market vantage point actually supported some of the choices.

In some cases, porting or moving between the choices is a straight-forward calculation, and in some cases it is arguably not. For example, any term structure can easily be converted into a yield measure; it is more difficult to convert a (one) yield measure back into a term structure. It is equally easy to present the present value of all the cash-flows of a bond in *yield-to-maturity* or in *daily returns*; both also offer different interpretations.

In cases where porting between constructs and measures are not an easy task, it may be best to approach the underlying choice from the market vantage point. Reactions towards rating announcements are conscious decisions by the market; they ought to execute the decisions from their vantage point. Whilst the appropriateness of the market vantage point can be questioned at any time, any measurement of reaction is purest from this particular vantage point, especially when information is altered (distorted) when porting to another vantage point.

7.6 The Risk-free Term Structure

It must be that ratings are also inter-related with market sophistication. A market may not respond to ratings because it misinterprets the rating information – the market finds it difficult to see how the perspective of rating agencies applies, for various reasons. Market sophistication is seen as closely related to market efficiency; market sophistication can be further explained as the level of conversation possible within the market, the relative depth with which specific factors and determinants impacting the market and market participants can be referenced.[99] The risk-free term structure in turn should be a very good reflection on market sophistication.

A number of previous sub-sections have already pointed to the importance of the risk-free term structure with regards to corporate bonds. Under Section 4 the risk-free term structure impacts on the cost of default. Under Section 7.1 it was found that, when discounting bonds to present value, only in the best case scenario does risk-free yields data match term structure data. In addition, it becomes very easy to discard and aggregate important information captured by term structures when substituting the term structure with yields data. These points all impact on bond prices and thus market efficiency.

It is not clear how sophisticated the South African market is when it comes to the risk-free term structure. Market correspondence – market conversations and information dissemination – seems to be rather based on yields data than term structure data. National literature also seemingly supports this view rather than refuting it. The matter will not receive considerable attention here - it is proposed that future research further explore the issue.

With regards to term structure decomposition, Stander (2001) completed an excellent comparative work on various models, plus the study is based on the South African context; West (2007) is also a good reference. Rather than focusing on *term structure decomposition*, the objective of this sub-section is to briefly look at *term structure composition*. In most cases the key criteria of *term structure decomposition* is model fit – the degree or magnitude of model error after a model has been fitted to market prices, measured as the difference between model prices and market prices. This of course presumes that market prices incorporate all available information at the time - that market prices are an efficient reflection of market conditions. Any model that fits market prices 100% will be greatly applauded, irrespective whether the market prices are fitting according to market conditions.

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[99] As a hypothetical example, record and compare market conversations - conversations between market participants – taking place within a) a developing market and a developed market, b) two developing markets, and c) two developed markets. With this information in hand, then compare price data between the respective market combinations.

The objective here is far less to conclude the matter, but rather to form *an idea* of the nature of term structure variation in the market. To do so, two factors regarding the term structure are briefly examined: a) absolute values[100] and b) periodic variation. These two points can generally be summarized as cross-sectional term structure variation. Two possibilities with regards to methods to measure cross-sectional term structure variation are proposed:

a) A yields data comparison between historic yields data on a number of issues and a historic risk-free term structure – a historic period is selected, and a number of risk-free bonds are isolated that were issued within the period and that also retired within the period. Next, the historic risk-free term structure is used to discount the issues and to calculate their yields data at routine intervals over the selected period. This is then compared with the yields data of the issues over the period

b) Decomposing the term structure at regular intervals over a specified historic period and comparing its movement with a historic risk-free term structure over the specified period.

Both methods are only possible in hindsight, mention a *historic risk-free term structure*, and involve a comparison over a period. The latter is necessary in order to note the amount of average cross-sectional variation presiding in the underlying measure (term structure or yields data).[101] A periodic comparison promises to be quite a revealing and useful exercise, particularly for the purposes of bond pricing. Regarding the notion of a *historic risk-free term structure* - in the case of the second method the historic term structure merely serves as some reference, and its use is generally not compulsory. Although the meaning stays the same, the historic term structure is however compulsory in the case of the first method.

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[100] …especially absolute values further "down the line".
[101] As an illustration on the point, decompose the term structure periodically (monthly, etc) over a period of time. Next, cluster the term structure plots - plot the various term structures under the same graph.

The first method really assumes that a perfect term structure exists and that it can be measured, albeit in hindsight. Argue that a perfect term structure exists under conditions of perfect information – (factors influencing) long term risk-free rates will thus be equally uncertain as (factors influencing) short-term risk-free rates. Therefore, it is possible to substitute long-term interest rates with short term risk-free rates and thereby construct (put together) a perfect term structure.

Therefore, it is possible to substitute the long-term risk-free rates pertaining to a certain point in time, point A, - i.e. the risk-free rates of points F, G, H, I…, with points F, G, H, I… (well) ahead of point A - with the short-term risk free rates of points F, G, H, I…, because the market had perfect information regarding these long-term risk-free rates and knew how they would eventually realize. Put differently, short term risk-free rates are routinely collected over a selected period to construct (plot) the perfect risk-free term structure that existed at the beginning of the selected period. It should be apparent why it is only possible to construct such a term structure in hindsight.

The approach is really an approximation: perfect information only means that a) all information that can be known at any time is known, and b) that what essentially constitutes as information is known. Perfect information however does not specify that the information is to remain constant. Should information pertaining to a particular point of (on) the term structure change at any time prior to the time represented by the particular point, then the term structure will also change. Thus, even the perfect term structure is not without cross-sectional variation.

In essence, the difference between the perfect term structure mentioned above and a market derived term structure is:

a) The accuracy or success rate of the model(s) used to decompose the term structure, i.e. model error or decomposition error – assuming that it is in fact necessary to decompose term structures[102]

b) All underlying factors influencing (specific points on) the term structure are known, and the factors can be measured without error

The study plans to utilize the second method – decomposing the term structure at regular intervals. With regards to the method, it is accepted that some of the measured variation can be attributed to the application of an imperfect term structure decomposition model under imperfect conditions. Different results may thus be achieved through the use of different models, also applied to different data (for instance, SWAPS-data versus bond-data). [Nevertheless, any difference should be within limitations – excessive differences of phenomenal magnitude seem unrealistic.]

In addition, any measured variation may be ascribed to market conditions and/or market utility; it is not to say that the market faired badly if a lot of variation is measured. Nevertheless, a lot a variation in itself is least desirable, because of its implications.

A rough indication on the extent of variation induced by the decomposition model may be obtained by first of all applying the model to a historic term structure – a historic series of short term risk-free rates. In essence, the historic term structure is used to routinely discount a number of issues – even hypothetical ones - over a period, to derive "real" periodic price data for the issues. Next, the model is then applied to the "real" data at regular intervals over the period and the model error is noted (by plotting the model-derived term structure along with the historic term structure). The study didn't attempt a measure of the potential variation introduced by the model.

[102] If it is assumed that term structure decomposition is redundant under conditions of perfect transparency, the need for term structure decomposition may not exist if perfect transparency exists in the market between market participants constructing (initially pricing) the term structure and market participants utilizing the term structure. This in turn assumes that certain market participants (who are incentivized to do so) actually consciously price certain points of the term structure, possibly as opposed to "generalizing" (points).

Spot-rates and Forward-rates were calculated through application of the model of Nelson and Siegel (1987), as adopted for coupon-paying bonds by Elton et al (2001). The model equations are shown below. In the equations CF_{it} refers to the cash flows of a particular issue i, and P_{0t} is the price of issue i at time 0; r_{ot} refers to the modelled, annualized spot rate for time t (period 0 - t).

$$P_{i0} = \sum_{t=1}^{T} CF_{it} \times D_t$$

$$D_t = e^{-r_0 t}$$

$$r_{0t} = \alpha_0 + (\alpha_1 + \alpha_2)[\frac{1 - e^{-\alpha_3 t}}{\alpha_3 t}] - \alpha_2 e^{-\alpha_3 t} \qquad \textbf{[37]}$$

The model was used to derive monthly rates over the period January 1997 to March 2008 – the model was applied to a different set of monthly all-in price data a number of times (11x12+3). Although cross-sectional variation was never investigated over a period longer than ten years, each time the model was left to assign rates up to the period 2038. Not all month-points in the period 1997 – 2008 were covered by issues that had cash-flows stretching up to 2038. In these cases the more distant reported rates are merely a natural extension of the equation that was fitted to the data.

Both a sample and sub-sample of government fixed-rate vanilla bonds were utilized; the sample comprised of both liquid and potentially illiquid issues and the sub-sample only of liquid government bonds – see Table 29 under APPENDIX H.

Figure 15 shows the Spot-rate curves and Forward-rate curves of the greater sample; Figure 16 shows the Spot-rate and Forward-rate curves of the liquid-issues sub-sample. It seems if the former benefited from the inclusion of more bonds and thus data points.

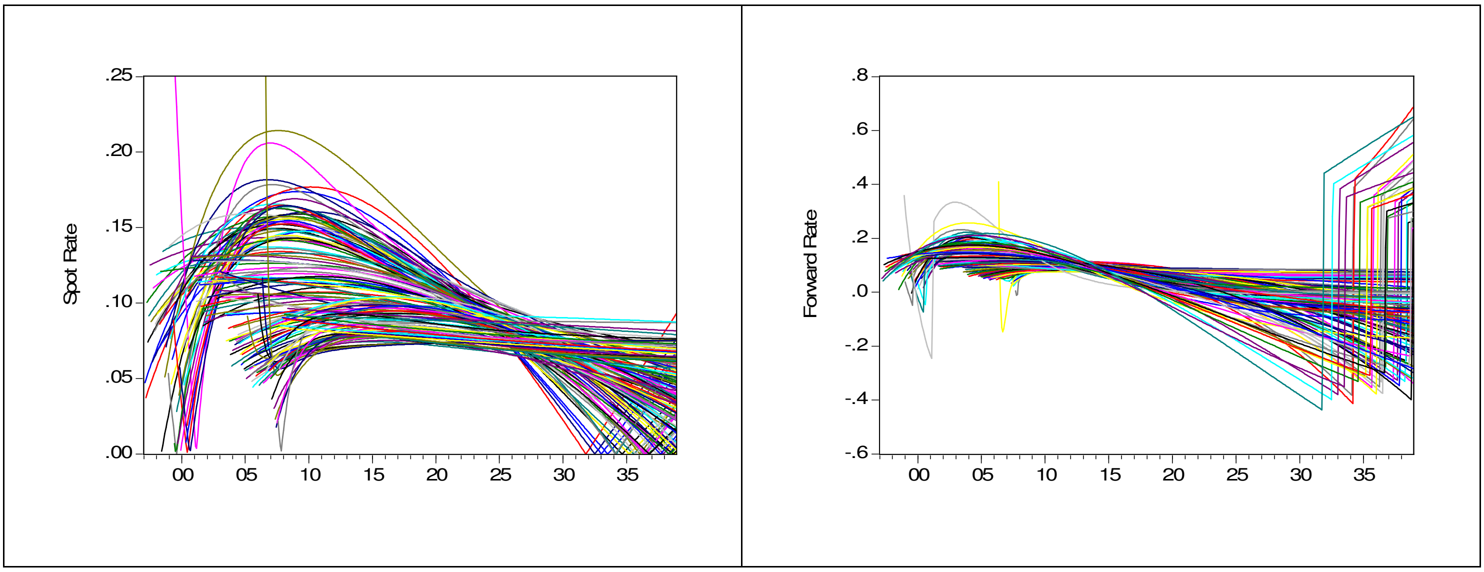

Figure 15. Monthly Spot-rate and Forward-rate curves for a sample of government bonds over the period January 1997 to March 2008

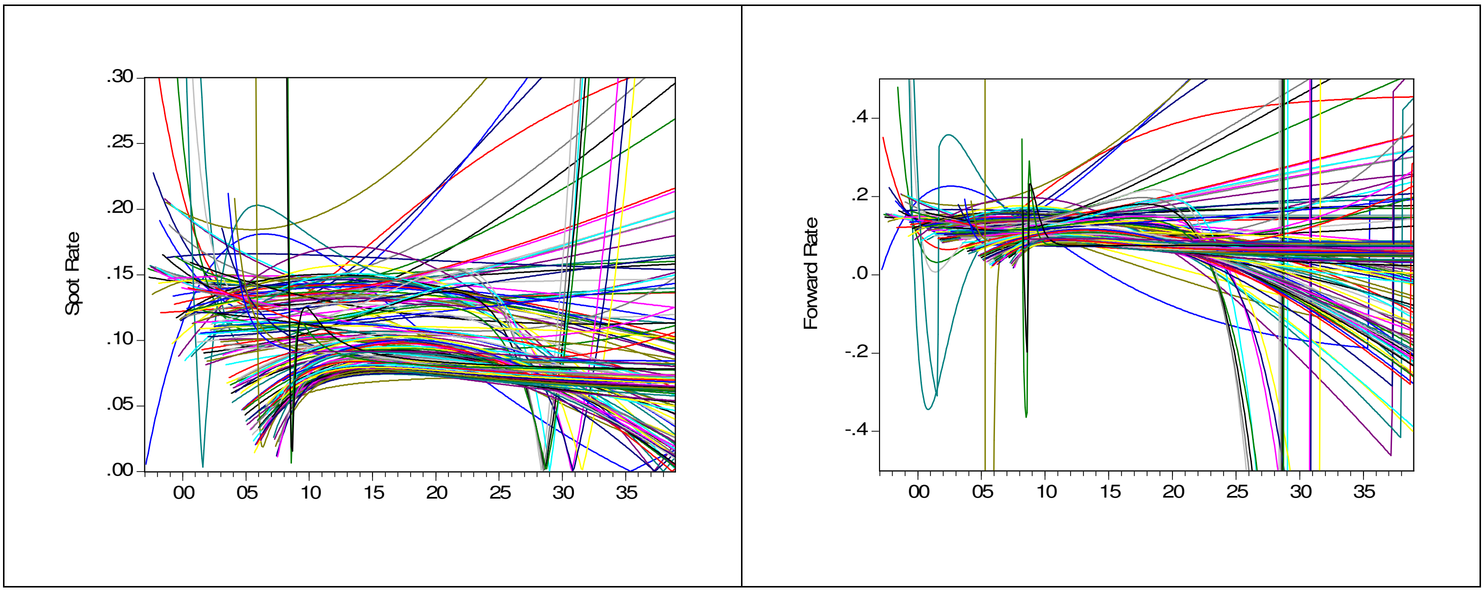

Figure 16. Monthly Spot-rate and Forward-rate curves for a sub-sample of liquid government bonds over the period January 1997 to March 2008

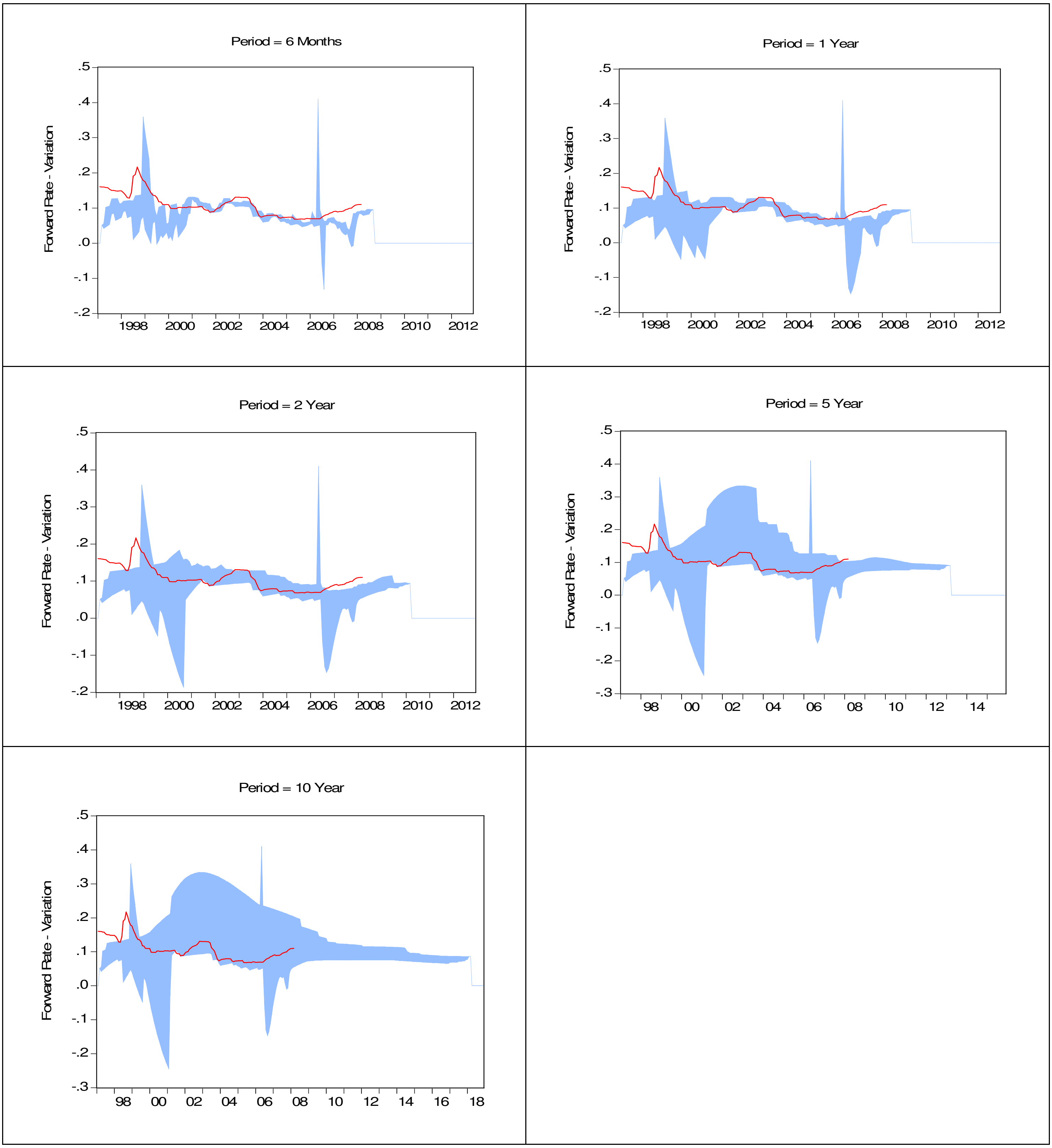

Figure 17. Cross-Sectional Variation in Forward Rates over the period January 1997 to March 2008 – minimum and maximum values

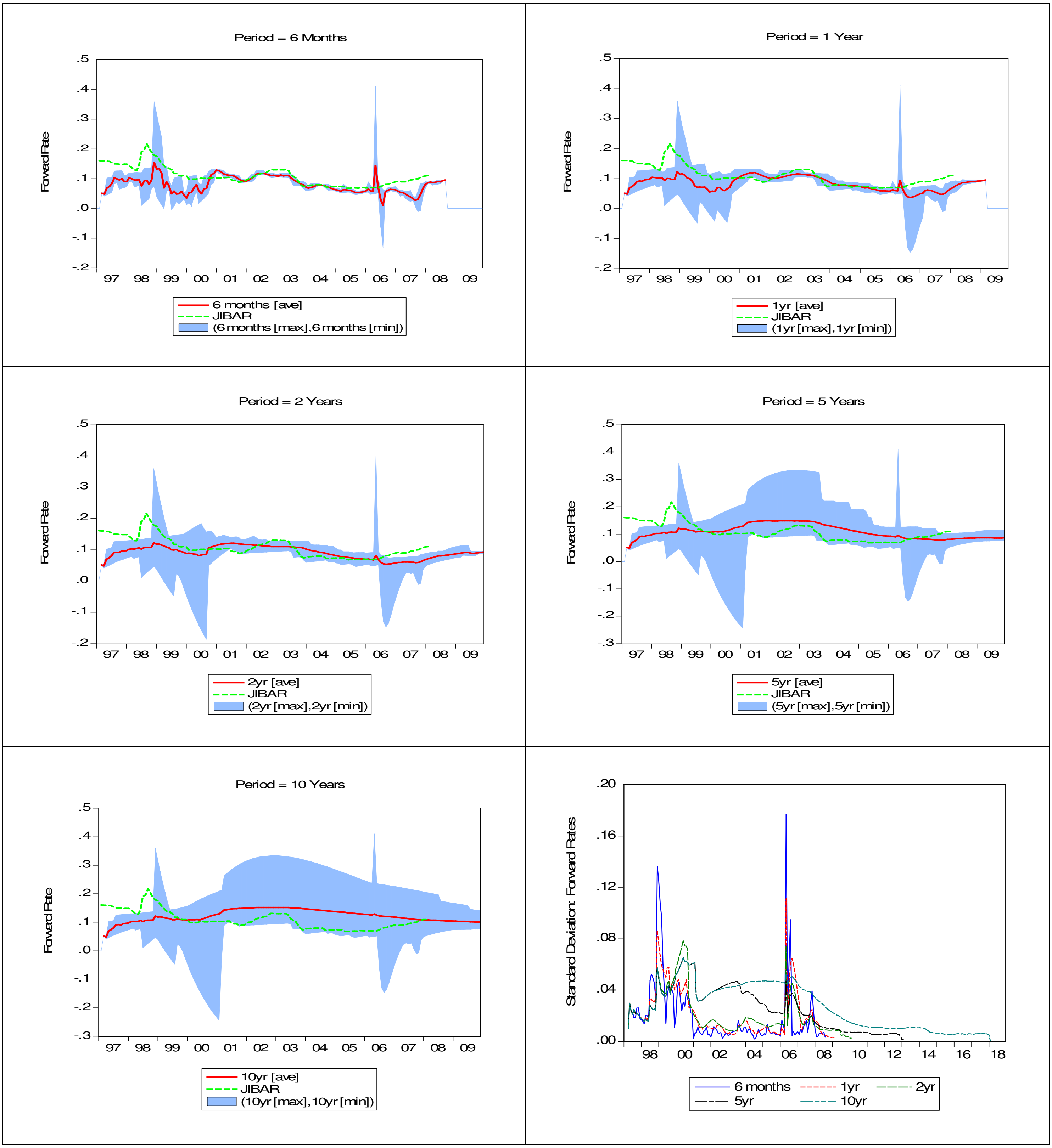

Figure 18. Cross-Sectional Variation in Forward Rates over the period January 1997 to March 2008 – average values and standard deviations

Figure 17 and Figure 18 delineate cross-sectional variation in forward rates, calculated over periods of ten, five, two, one, a half year(s), respectively. In Figure 17, variation in forward rates is calculated as the minimum and maximum values of a number of monthly forward rates. In Figure 18, variation is calculated as the average - rather than the minimum and maximum - of a number of monthly forward rates. [Figure 18 also captures the standard deviation of the average forward rate calculation.] In both figures variation is calculated for each month over the period 1997 – 2008. To calculate variation a cross-sectional sample is taken for each month. Sampling starts with the first forward rate value available for the particular month and the sample size depends on the number of months within the period variation is investigated over – i.e. [10; 5; 2; 1; 0.5] times twelve.

The base-line in the graphs of Figure 17 and Figure 18 is the three-month inter-bank rate – the three-month Johannesburg Interbank Agreed (JIBAR) rate.

It is believed that a great deal of variation evident in the graphs is due to an imperfect model applied under imperfect conditions – data as one. It is also believed that the data (imperfect conditions) contributed more variation that the model itself. Regardless, in none of the cases were all available information – information in addition to that required by the model – incorporated; more sophisticated modelling was in fact possible, but it increased complexity and thus fell outside the scope of the study.

In the analysis to follow the figures are interpreted as is; it is acknowledged that the variation introduced through modelling can impact the interpretations.

Figure 15 and Figure 16 really report on absolute values. This will not really be discussed here, apart from mentioning that in some cases negative rates where measured and in some cases it appears as if the rates fall (rate of decrease) too quickly. This may or may not be due to modelling. Ideally, a single, albeit thick, line is expected – in essence look at the relative thickness of the graphs of Figure 15 and Figure 16.

Figure 17 and Figure 18 generally report:

a) Cross-sectional forward rate variation spread - the minimum and maximum value a tem structure point can take on (normally takes on)

b) The progression of movement within cross-sectional forward rate variation – the relative distance between the forward rate average of a point and the minimum and maximum values of the point

c) The relative position of cross-sectional forward rate variation to a base rate

In Figure 17, note how forward rate variation spread increases as the length of the period increases (from six months to ten years). Also note that the minimum values are not always greater than the base (JIBAR) rate.

In Figure 18, the average forward rate value is generally centred within the minimum/ maximum spread only for the shorter periods, i.e. the six-month, one-year and two-year periods. In the five-year and ten year periods, the average value is normally positioned closer to the minimum value. The average forward rate value is also not always greater than the base (JIBAR) rate.

The risk-free term structure and also variation/ uncertainty in the risk-free term structure are imperative to bond prices and bond pricing. Term structure variation resembles uncertainty and increases the cost of default (see Equation [20]). Term structure variation is relevant over the lifetime of bond. Cross-sectional term structure variation was measured over an extensive period. Interestingly, cross-sectional forward rate spread and its average not always exceeded the base rate – refer to Figure 17 and Figure 18. Also, the amount of cross-sectional variation measured in the market is in strong contrast with the nature of corporate bond prices measured in the market.

This section hardly received the amount of attention it deserves, partly because it only forms a sub-part to the study's core focus. The section can be further extended by introducing Literature on Interest Rate Modelling, in addition to Literature on Term Structure Decomposition. It is left to future research to further look into the topic of variation in the risk-free term structure.

8 CONCLUSION

The study is characterized by a small sample, with virtually no corporate references available for the few observations that were studied. The yield series of the observations within the study sample were generally very stationary, the observations were poorly traded, and pricing within the market at the time may raise questions. Whilst the methodology of the study could more or less circumvent the former two factors, the latter three are more difficult to practically overcome. The power of the test under the conditions inflicted by the market context becomes a key question; this study did not aim to resolve the impact poor trade and pricing had or may have had on the statistical test and thus the results. This relates to the power of the test and it is left to future research.

The study also did not attempt to resolve whether pricing in the market was just over the study period. The lack of corporate references hindered a more sophisticated and precise measure of abnormal performance. Due to certain practicalities, only the rating data of one rating agency was examined. In the future, the research can be expanded by also incorporating the rating data (databases) of other rating agencies.

The study individually examined the yield spreads of ten issues; the issues naturally differed in their respective time-to-maturity. The issues were related to five issuers. Two of the issues (two issuers) experienced downgrades, whilst eight of the issues (three issuers) experienced upgrades. Almost all of the issues studied were of high-quality investment grade, and none of the rating changes involved a change of more than one notch.

To complement the study, an additional sub-sample comprising of a number of callable vanilla bonds were also studied, albeit separately. The inclusion contributed two downgrade cases and seven cases of upgrades. Again, the rating change was never by more than one notch. Because these issues did not form part of the study's main focus, analysis was however not as rigorous as was the case for non-callable issues. Given that it appears as if callable bonds are being issued more frequently, future research should consider extending the research to callable vanilla issues.

Stationarity and unit-root tests were conducted on the non-callable and callable issues' individual price series to determine whether the issues experienced significant price impacts in response to their respective rating-change announcements.

Only a number of non-callable issues experienced significant impacts. The number shrunk considerably after contamination could be proven in some cases, and when the directions of the yield spread movements were taken into consideration.

An even smaller number of callable issues registered significant impacts. Contamination was not that customary in the case of callable issues, but direction of movement still played a role.

Overall, of the ten non-callable issues, none appear to have been impacted by their respective rating changes; of the nine callable bonds, only one may have been impacted by a rating change, conditional on the issue's call option.[103] Recall that no "serious" rating changes occurred.

To better support the research findings, the power of the selected statistical tests, as applied to bond pricing data, should be examined. Methods to do so follow the work of Brown and Warner (1980; 1985) and Boehmer et al (1991), and were discussed previously. Also, in some of the cases the rating changes were preceded by rating warnings – whether rating outlooks or rating watches – and it may be insightful to investigate whether the market responded to these warnings.

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[103] Based on the statistical tests that were applied to the issues' yield series, the following non-callable issues posted significant impacts in response to rating changes: [AG01; FRBN2; FRBN03; HAR1-A; HAR1 (B)]. [FRBN02] had a time-to-maturity of two months at the time of rating change, and this is seen as sufficient reason to ignore its price movements. [AG01] and both cases of [HAR1] were clearly contaminated. Although [FRBN03] was seemingly not contaminated, its direction of change is opposite to that implied by its rating change; the issue's clear direction of movement over its longer window period further supports this assessment. Only two callable vanilla issues posted significant impacts: [NED1; SLI1]. It appears if none were contaminated. In the case of [SLI1] overall direction of movement is contradictory to the rating change; the series also measures trend stationary, indicating that the rating change probably did not work in on the series. [NED1] was not found to be trend-stationary or contaminated.

In contrast to previous studies, cases where issuers had multiple issues affected by a rating change were in fact not rationed to only one issue per issuer. Remarkable about cases with multiple issues under investigation is that not all issues of the same issuer actually reported coinciding yield spread movements, let alone similar yield spread movements in terms of magnitude and direction. Known by now, not all issues in the sample actually showed some price movement amidst the rating change. Furthermore, a case where an issue had a time-to maturity of only a few months at the time of its rating event was also investigated.

Pre-emptively, the findings show that it may very well be that issue-specific characteristics are as hard at play as the rating itself; at a very basic level the study also provides support for the notion that events do not impact all issues (companies) in the same way (see Boehmer et al 1991). Issue-specific characteristics cannot be ignored during any inquiry into the impact of ratings and rating changes on bond prices; the remaining time-to-maturity at the time of a rating change is surely to impact the reaction to a rating change, because it reflects on the underlying cash flows affected by the rating change. It is not clear how agencies approach Maturity.

In distinguishing between significant impacts and economical impacts, exactly how to assess if economical impacts occurred is not clear, especially in the cases where the investigation is extended to single issues as opposed to a group of issues. With clustering the likelihood exists that impacts may be averaged out. This is rather impossible with an investigation on an individual level though. Without inferring to the origin or relative window-period position thereof, some of the issues did show remarkable price movements - measured as the respective yield spread change.

Is it in fact possible to measure an “economical” price impact in any rating event? In the end, the isolated price movement of any event under study, believed to be in response to the rating action, should link back to its default risk in some way; the rating is irrelevant to liquidity and taxability premiums.[104] When considering that, in the case of bonds, default risk implies lost cash-flows (coupons and a fraction of the par-value) it means that a certain number of cash flows should be under a certain amount of risk in order to register a certain level of price movement.

The converse must also hold - to register a certain level of price movement, a certain number of cash flows should be under a certain amount of risk. It appears as if some cases will not reveal economical price movements – the rating change is not significant enough in terms of risk to cash flows, and/ or the number of outstanding cash-flows is not that numerous.

At many an occasion the literature review reverted to (to come to rest on) the root *determinants of bond prices*, and the root *determinants of credit ratings*; also, *market competencies* with regards to the determinants of bond prices and the true nature or meaning of *Private Information*. Two conditions seemed to prevail:

a) for ratings to have a independent impact on bond prices, the rating data must contain *Private Information*

b) *Private Information* in turn depends on of the root determinants of bond prices - predominantly the determinants ratings have direct discretion over or offer discretion over – and existing market competencies with regards to these bond price determinants

A good exemplification of the above is achieved by interpreting the equations developed under Section 4 – Equation [6] and Equation [20]:

> It is not to say that Rating Agencies have sole access to or competencies with regards to Equation [6] and Equation [20].

[104] This view does not discard the business cycle, downgrade risk, maturity, issuer-subcategory, etc as bond price determinants, but rather see them as an integral part of default risk.

Rating agencies must be able to calculate periodic default probabilities better than investors (the market) can – only a further deflation of periodic default probabilities will result in a price impact directly attributable to ratings. Conversely, a price impact can't be expected if rating agencies can't deflate periodic default probabilities any further than investors already did.

Similarly, any information collected by rating agencies or offered to third parties only constitute as *Private Information* if the information can be used to further deflate (demystify) periodic default probabilities. Both the market and agencies should also agree on the meaning of a *periodic default probability*.

Credit Ratings may theoretically only affect bond prices should the issuer have issues outstanding; a number of issuers experienced rating changes during the study period, but were not considered because they had no issues outstanding and thus no price data to study the impact of the rating change. Previous researches have also (already) looked at the impact of credit ratings on stock prices. Since stocks and bonds differ in terms of longevity (the stocks of public companies hardly "retire") an important distinction may be to differentiate between private information of (within) ratings pertaining to (the pricing of) bonds and private information of (within) ratings pertaining to (the pricing of) stocks. This has been the approach of research to date.

Thus, even if it can be shown that credit ratings contain no private information with regards to bonds, it may be that ratings contain private information with regards to stocks. Nevertheless, the argument prompts the following question: if ratings are not used by or intended for investors in bonds or stocks, who else would want to use it or benefit from using it? There is of course the company (issuer) itself, but this idea seems awkward – objectively, would a company select a rating agency over a consultancy firm and why/ why not?

Nevertheless, to answer whether ratings at least contain information relevant to the pricing of stocks, the aforementioned requirement seemingly still holds. If agencies are able to deflate (periodic) default probabilities even further, after the attempts of investors, then the information captured in the default probabilities (and associated with the agencies) must be informative about stocks - it ought to assist in equity valuation. It is anticipated that periodic default probabilities reflect on future cash flows, and the probability thereof.

Even still, what is interesting is that credit ratings were initially designed to help bond investors, not so much stock investors. In both cases, the degree by which default probabilities can be deflated essentially captures how significant an effect the rating can have on bond/ stock prices.

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APPENDIX A

Table 27. Methodologies of former studies

Study	General Methodology	Benchmark	Data
Katz (1974) [US Electric Utilities]	Regression	-	Monthly; Nominal Yields - gathered from S&P Bond Guides; Yield-to-Maturity regressed
Ingram et al (1983) [US Municipalities]	Statistical Tests applied to an Abnormal Bond Returns Sample *	Observation's Yield Spread: Treasury Bond (maturity, coupon) Relative Spread: Rating class Average Yield Premium	Monthly; Yield-to-Maturity - As published by Blue List; (T-) tests applied to yield spreads

Study	General Methodology	Benchmark	Data
Hawley and Walker (1992) [US Corporates]	Statistical Tests applied to an Abnormal Bond Returns Sample *	a) Moody's Investment Grade Bond Index; Constructed a junk bond index b) Matched Pair Technique (maturity, rating, SIC code)	Monthly; Closing ask prices or actual sale price; (T-) tests applied to returns
Hand et al (1992) [US Corporates]	Statistical Tests applied to an Abnormal Bond Returns Sample *	One long-term Treasury Bond as benchmark for all observations (maturity ignored)	Daily; Transaction prices; All bid prices were excluded; (T-) tests applied to returns
Wansley et al (1992) [US Corporates]	Statistical Tests applied to an Abnormal Bond Returns Sample *	Dow Jones Composite Bond Index	Weekly; Merrill Lynch Matrix prices; (T-) tests applied to returns
Hite and Warga (1997) [US Corporates]	Statistical Tests applied to an Abnormal Bond Returns Sample *	Lehman Brothers Bond Index (broad rating, maturity)	Monthly; Returns calculated from Trader Quotes; (T-) tests applied to returns

Study	General Methodology	Benchmark	Data
Steiner and Heinke (2001) [German Eurobonds]	Statistical Tests applied to an Abnormal Bond Returns Sample *	Duration-equivalent government bond (maturity, coupon)	Daily; Returns calculated from trader quotes; (T-) tests applied to returns
Gropp and Richards (2001) [European Banks]	Market Model Based - Abnormal returns calculated as actual returns minus forecast returns. Abnormal returns statistically tested	Market Index	Daily; Bloomberg data; Returns data from estimation period used to forecast event period expected returns. Abnormal returns calculated as actual returns minus forecast returns
Ammer and Clinton (2004) [US Asset-Backed Securities]	Based on Abnormal Bond Returns in part	Whole ABS index	Monthly; Merrill Lynch Fixed and Floating Rate Asset Backed Index ;(Bloomberg)

Study	General Methodology	Benchmark	Data
Dallocchio et al (2006) [French Corporates]	Phillips Perron test for stationarity	Observation's Yield Spread: Government Bond (maturity) Relative Spread: Merrill Lynch data: daily relative spreads per rating class and macro-industry	Daily; (Merrill Lynch Price/ Yield data?); Test applied to Yield spreads
Batchelor and Manzoni (2006) [Sterling Eurobonds]	Statistical Tests applied to an Abnormal Bond Returns Sample *	Matched Pair Technique (Initial rating, maturity, coupon, sector, country)	Daily; Returns calculated from trader quotes; (T-) tests applied to returns

* Abnormal Bond Returns implies $r_t - r_t^*$ - the holding period returns for a particular issue (r_t) minus the holding period returns of a reference bond or index (r_t^*).

APPENDIX B

Table 28. Issues under Study and Corporate Reference Bonds – Issue-specific characteristics

Issue	Issuer – Sub-category	Coupon Rate	Maturity Date	Pre-event Rating	Post-Event Rating	Issue Date
AG01	Industry – Mining	10%	2008/08/28	AA (zaf)	AA- (zaf)	2003/08/28
SBS2	Banking	8.33%	2008/04/18	AA+ (zaf)	AA+ (zaf)	2005/04/18
FRBN01	Banking	13%	2010/08/31	AA- (zaf)	AA (zaf)	2004/03/04
BAW1	Industry	10.7%	2011/07/29	AA- (zaf)	AA- (zaf)	2004/07/29
SPG1	Industry	12.5	2008/06/25	A- (zaf)	A- (zaf)	2004/06/25
FRBN02	Banking	12%	2006/02/28	AA- (zaf)	AA (zaf)	2004/03/31
DC01	Industry	10.75%	2007/09/25	-	-	2001/09/25
HAR1	Industry – Mining	13%	2006/06/14	BBB+ (zaf)	BBB+ (zaf)	2001/06/08
SHF01	Industry	10%	2008/02/28	A (zaf)	A (zaf)	2003/12/08

Issue	Issuer – Sub-category	Coupon Rate	Maturity Date	Pre-event Rating	Post-Event Rating	Issue Date
FRBN03	Banking	10%	2008/02/28	AA (zaf)	AA+ (zaf)	2004/04/22
DEN1	Industry	12.8%	2007/08/16	AA (zaf)	AA (zaf)	2002/08/13
SBK6	Banking	7.7%	2007/03/01	AA+ (zaf)	AA+ (zaf)	2005/02/25
SBS2	Banking	8.33%	2008/04/18	AA+ (zaf)	AA+ (zaf)	2005/04/18
SHF01	Industry	10%	2008/02/28	A (zaf)	A (zaf)	2003/12/08
SPG1	Industry	12.5%	2008/06/25	A- (zaf)	A- (zaf)	2004/06/25

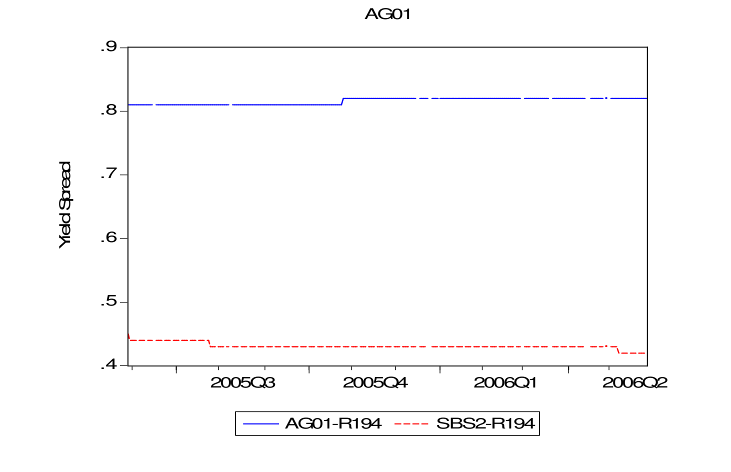
HAR1A	Industry – Mining	13%	2006/06/14	A (zaf)	A- (zaf)	2001/06/08
AG01	Industry – Mining	10%	2008/08/28	AA (zaf)	AA- (zaf)	2003/08/28
DEN1	Industry	12.8%	2007/08/16	AA (zaf)	AA (zaf)	2002/08/13
SHF01	Industry	10%	2008/02/28	A (zaf)	A (zaf)	2003/12/08

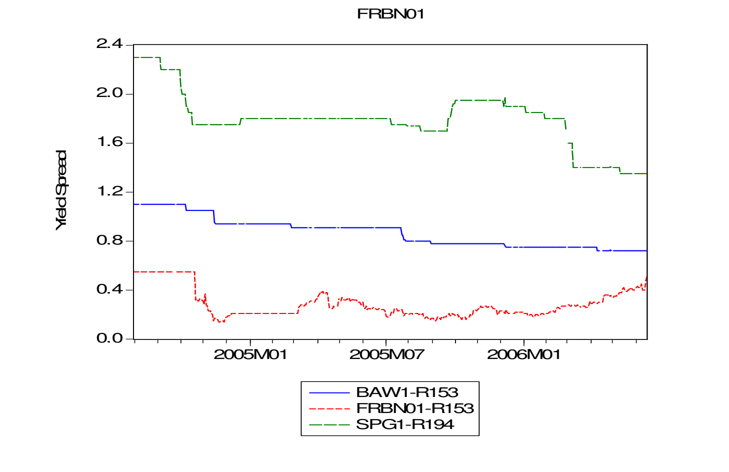
HAR1B	Industry - Mining	13%	2006/06/14	A- (zaf)	BBB+ (zaf)	2001/06/08
SHF01	Industry	10%	2008/02/28	A (zaf)	A (zaf)	2003/12/08

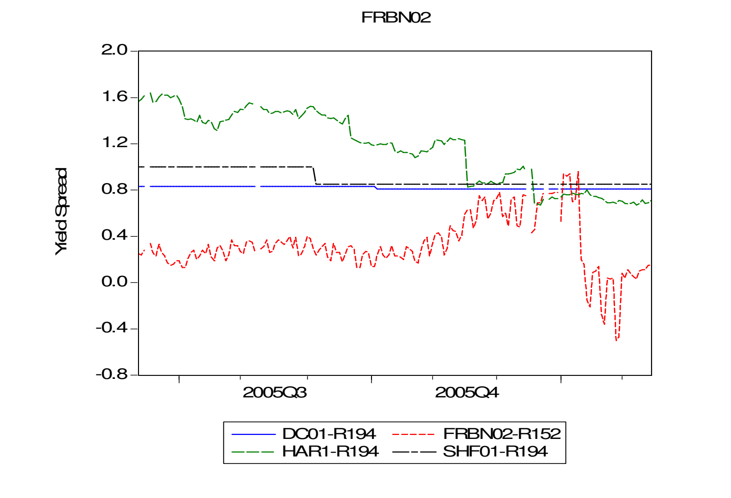
Issue	Issuer – Sub-category	Coupon Rate	Maturity Date	Pre-event Rating	Post-Event Rating	Issue Date
IV01	Banking	16%	2012/03/31	A+ (zaf)	AA- (zaf)	2000/06/17
MTN01	Corporate – Utility	10.01%	2010/07/13	A+ (zaf)	A+ (zaf)	2006/07/13
SMF1	Industry	9.34%	2013/06/27	AA- (zaf)	AA- (zaf)	2006/06/27
SBK4	Banking	12.5%	2005/02/15	AA (zaf)	AA+ (zaf)	2002/06/26
FRBN02	Banking	12%	2006/02/28	AA- (zaf)	AA- (zaf)	2004/03/31
SBN6	Banking	13%	2009/08/31	AA (zaf)	AA+ (zaf)	2004/02/16
AG01	Industry – Mining	10%	2008/08/28	AA (zaf)	AA (zaf)	2003/08/28
FRBN01	Banking	13%	2010/08/31	AA- (zaf)	AA- (zaf)	2004/03/04
DEN1	Industry	12.8%	2007/08/16	AA (zaf)	AA (zaf)	2002/08/13

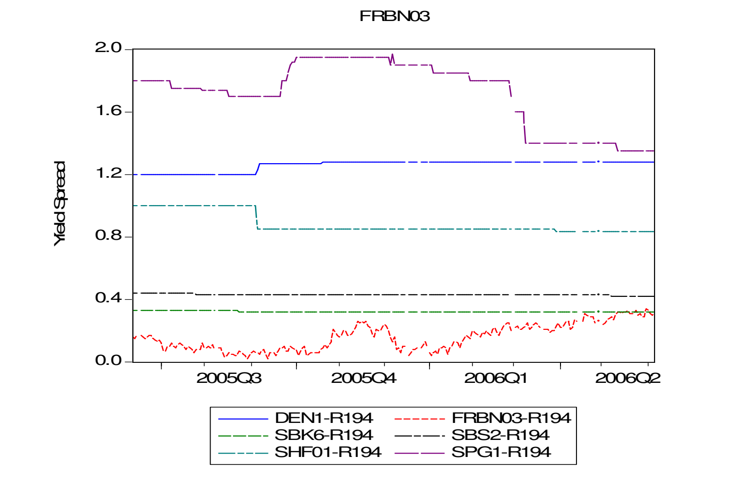
Issue	Issuer – Sub-category	Coupon Rate	Maturity Date	Pre-event Rating	Post-Event Rating	Issue Date
SBN7	Banking	13%	2010/08/31	AA (zaf)	AA+ (zaf)	2004/02/16
AG01	Industry – Mining	10%	2008/08/28	AA (zaf)	AA (zaf)	2003/08/28
FRBN01	Banking	13%	2010/08/31	AA- (zaf)	AA- (zaf)	2004/03/04
SBN8	Banking	13%	2011/08/31	AA (zaf)	AA+ (zaf)	2004/02/16
FRBN01	Banking	13%	2010/08/31	AA- (zaf)	AA- (zaf)	2004/03/04

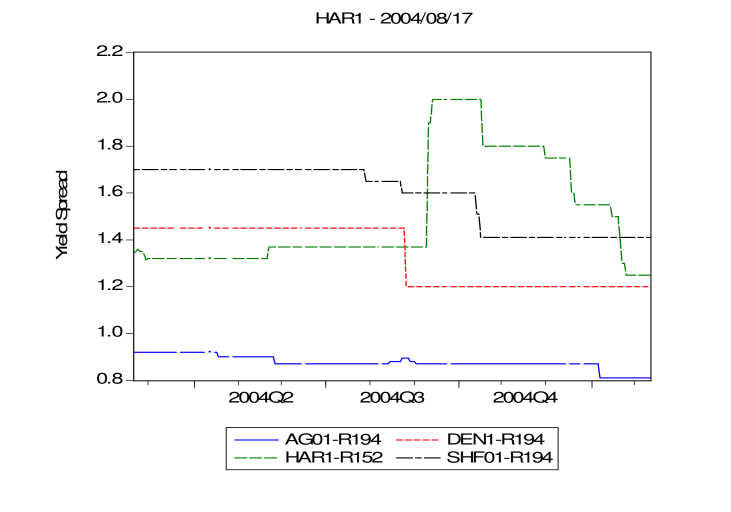
Corporate References – [-180; 180]

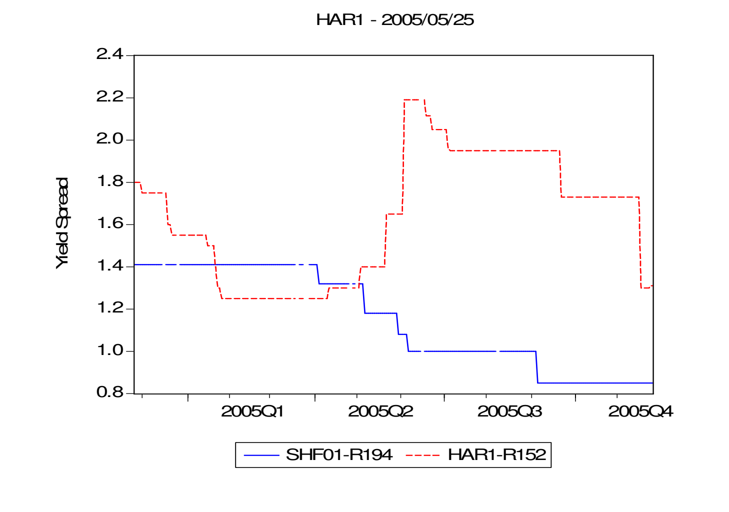


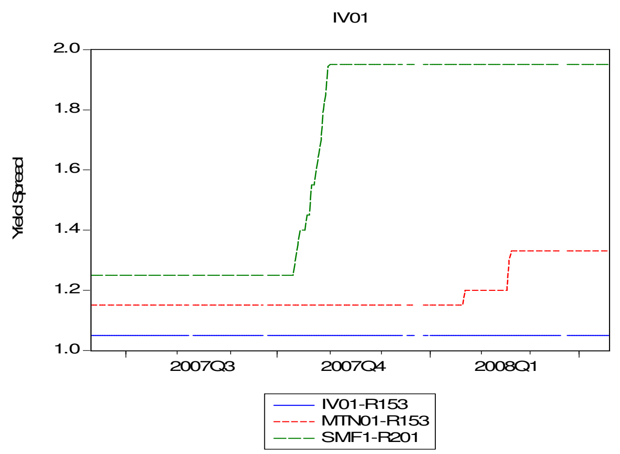


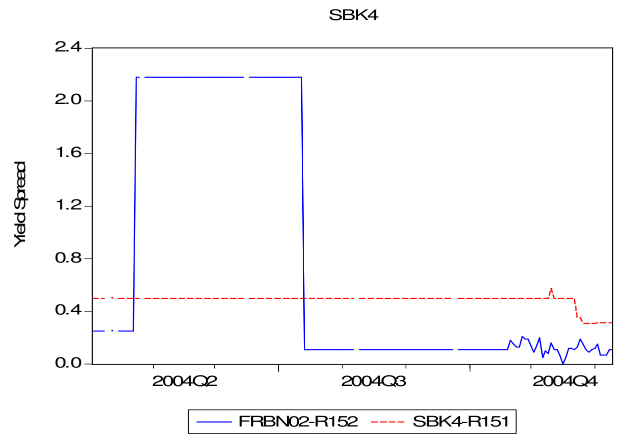


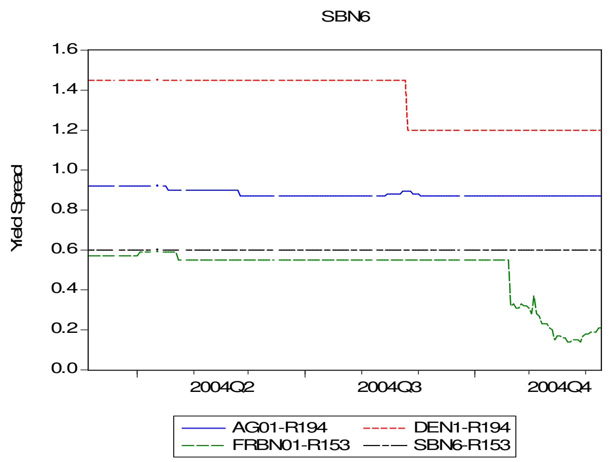


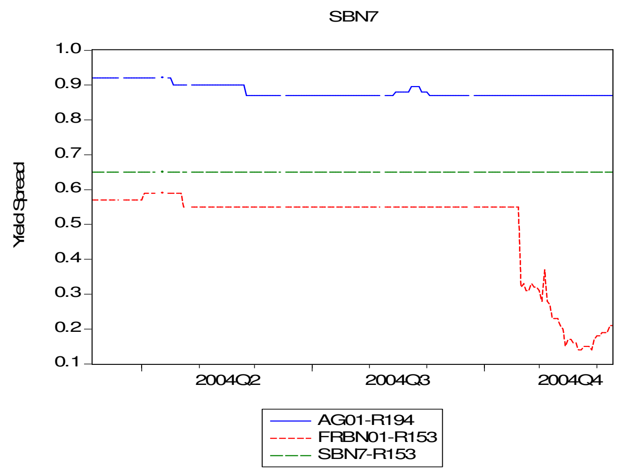


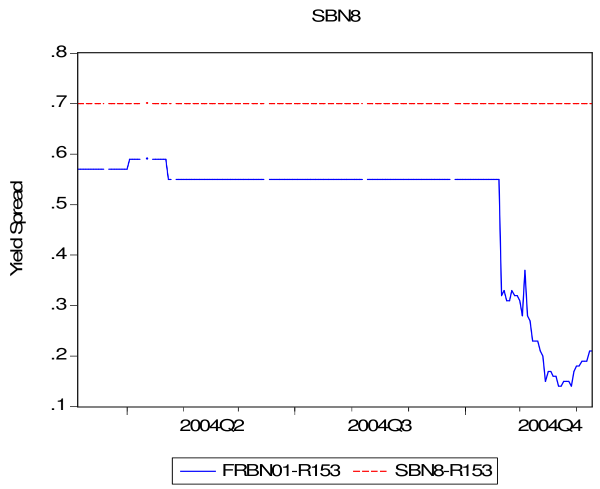



IV01
Yield Spread
2.0
1.8
1.6
1.4
1.2
1.0
2007Q3
2007Q4
2008Q1
IV01-R153
MTN01-R153
SMF1-R201

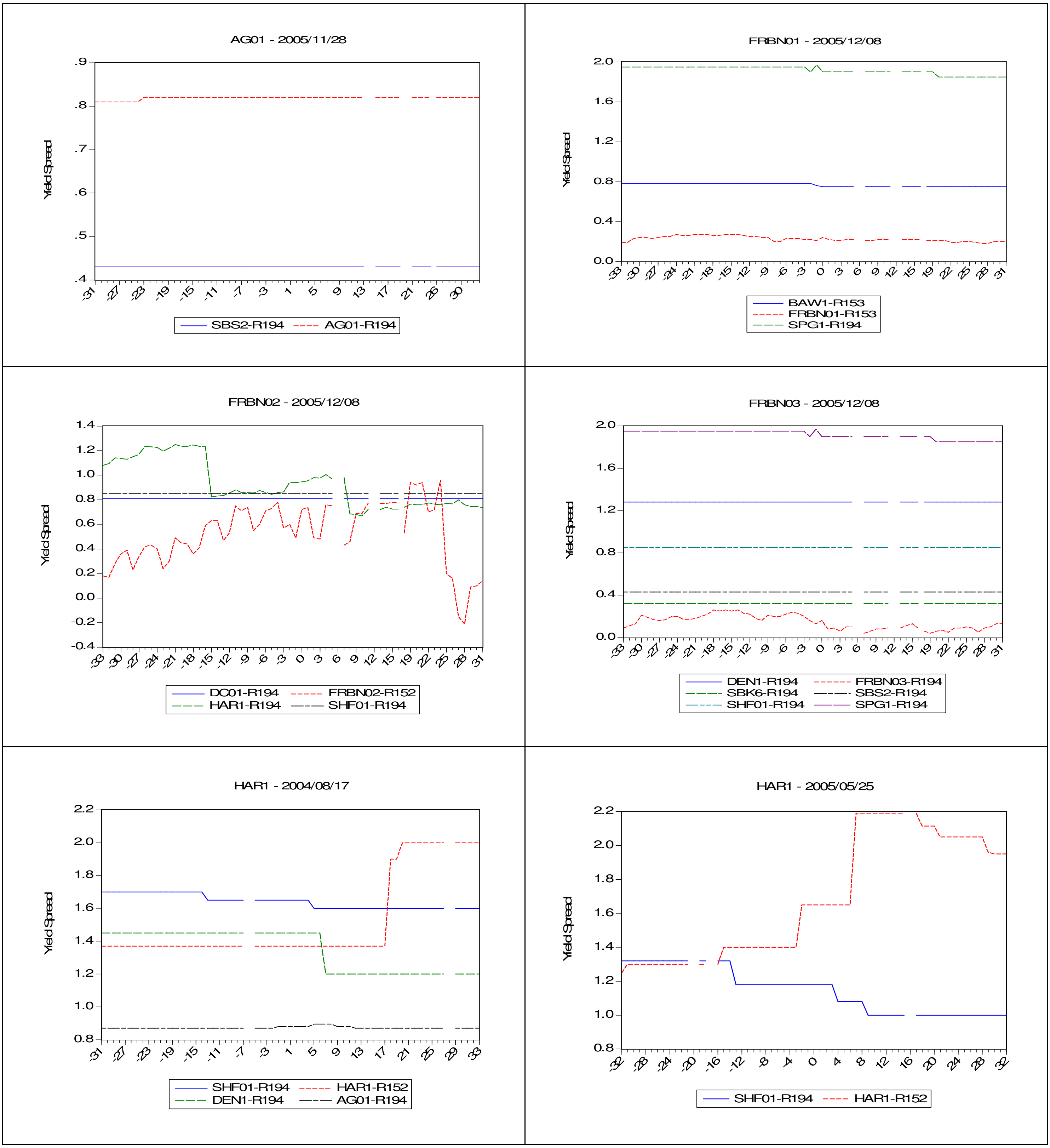

SBK4
Yield Spread
2.4
2.0
1.6
1.2
0.8
0.4
0.0
2004Q2
2004Q3
2004Q4
FRBN02-R152
SBK4-R151

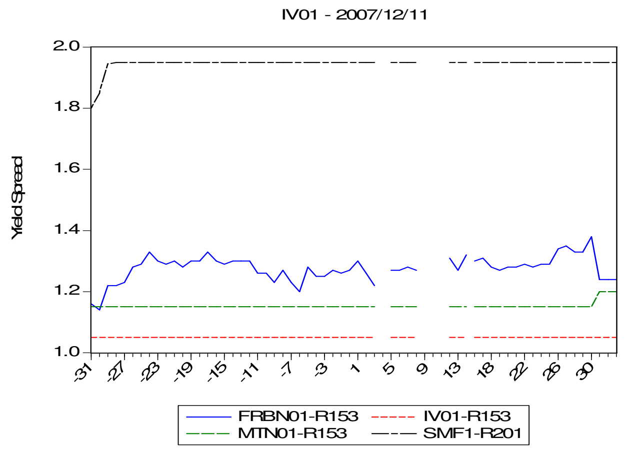

SBN6
Yield Spread
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2004Q2
2004Q3
2004Q4
AG01-R194
DEN1-R194
FRBN01-R153
SBN6-R153

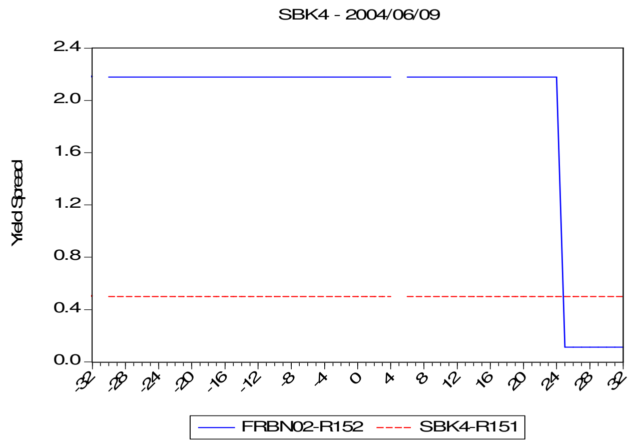

SBN7
Yield Spread
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
2004Q2
2004Q3
2004Q4
AG01-R194
FRBN01-R153
SBN7-R153

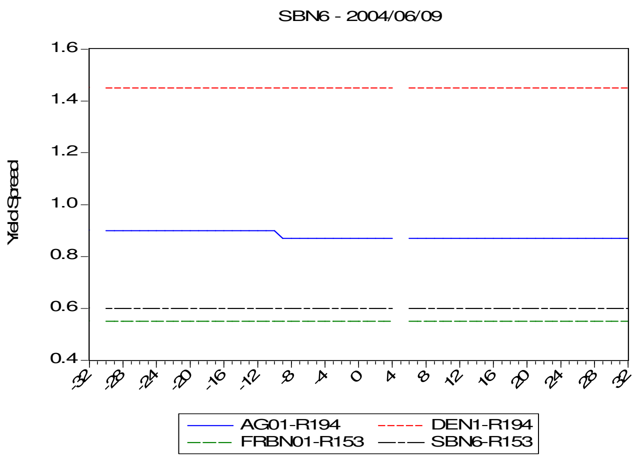

SBN8
Yield Spread
.8
.7
.6
.5
.4
.3
.2
.1
2004Q2
2004Q3
2004Q4
FRBN01-R153
SBN8-R153

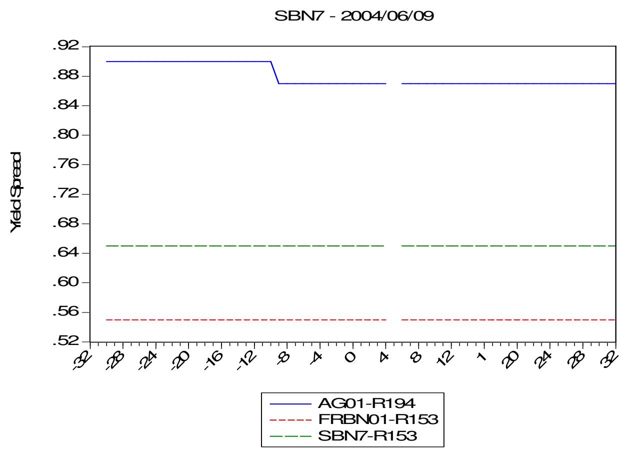
Corporate References – [-45; 45]

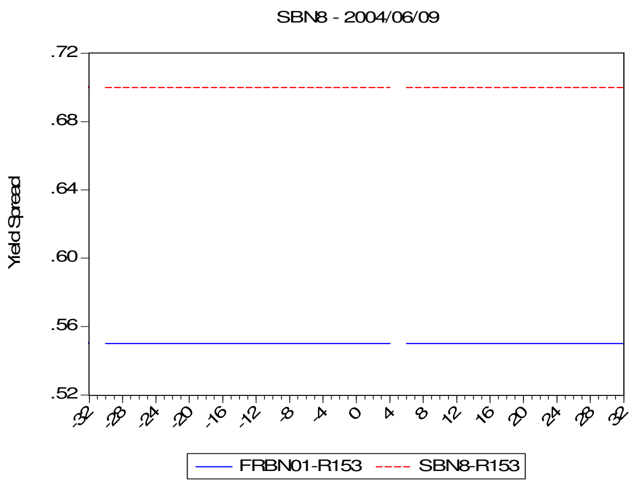



IV01 - 2007/12/11
Yield Spread
FRBN01-R153
IV01-R153
MTN01-R153
SMF1-R201


SBK4 - 2004/06/09
Yield Spread
FRBN02-R152
SBK4-R151

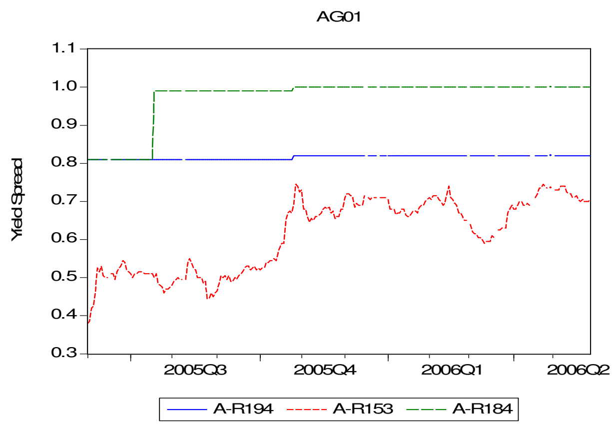

SBN6 - 2004/06/09
Yield Spread
AG01-R194
DEN1-R194
FRBN01-R153
SBN6-R153

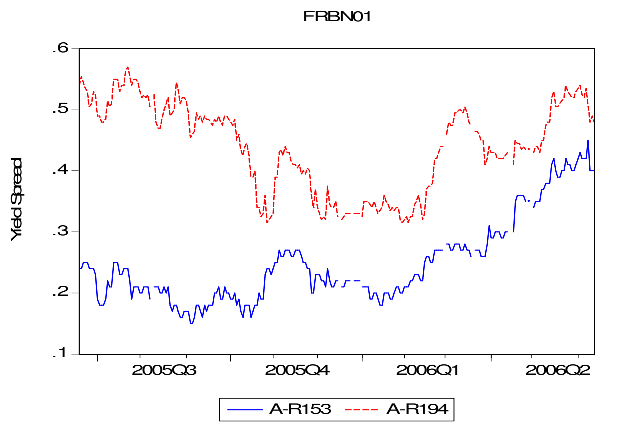

SBN7 - 2004/06/09
Yield Spread
AG01-R194
FRBN01-R153
SBN7-R153

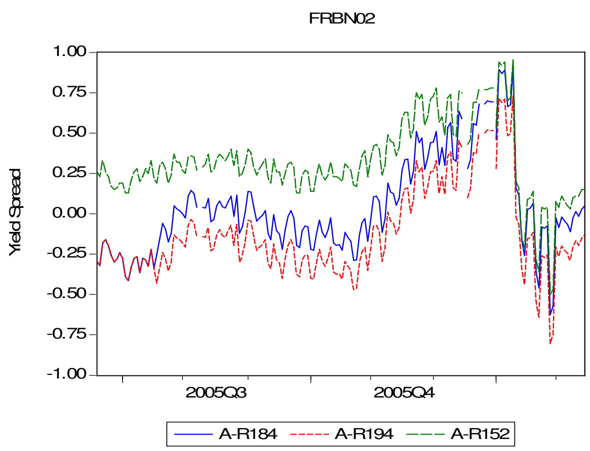

SBN8 - 2004/06/09
Yield Spread
FRBN01-R153
SBN8-R153

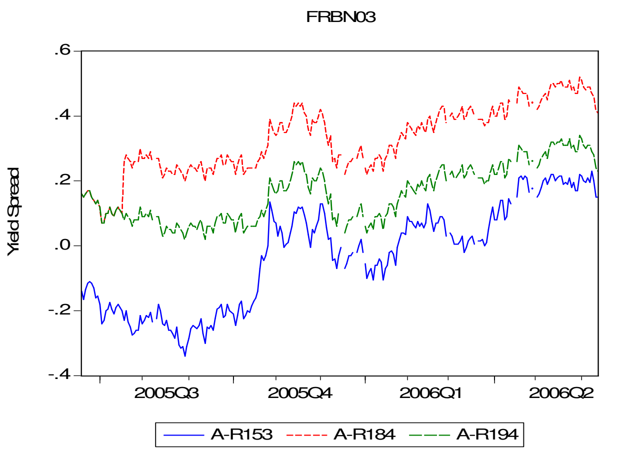
APPENDIX C

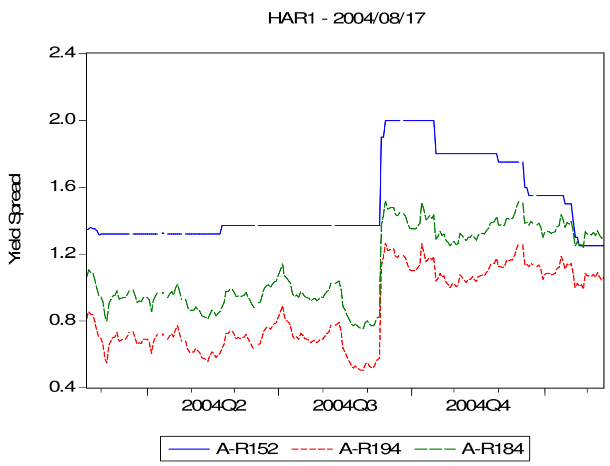
Corporate | Government – Yield Spreads [-180; 180]

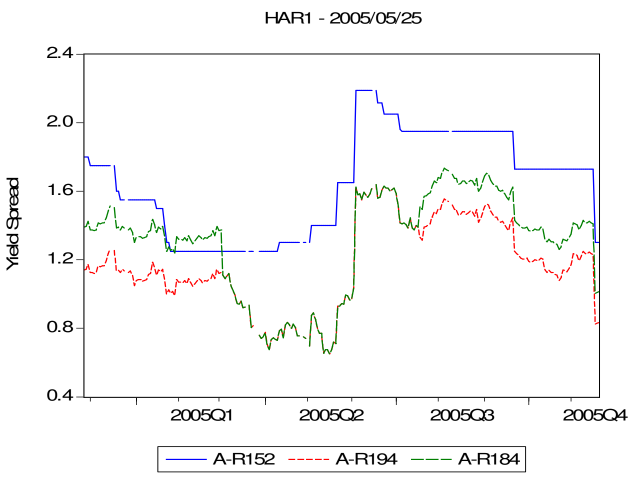


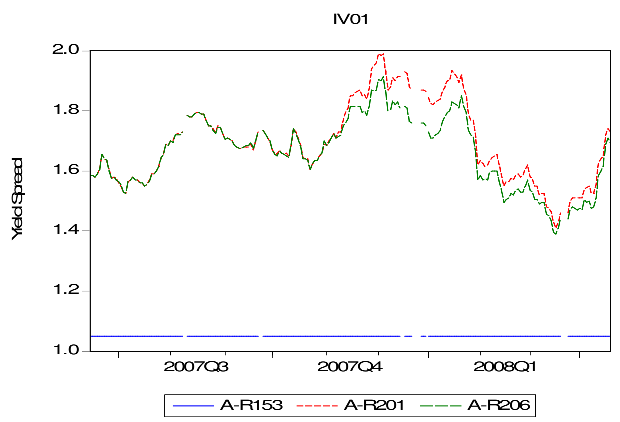


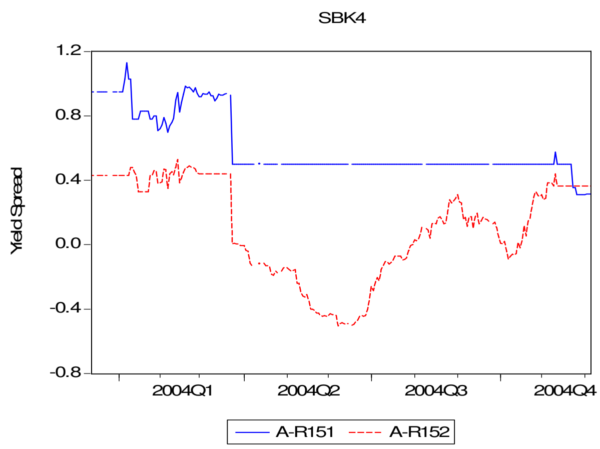


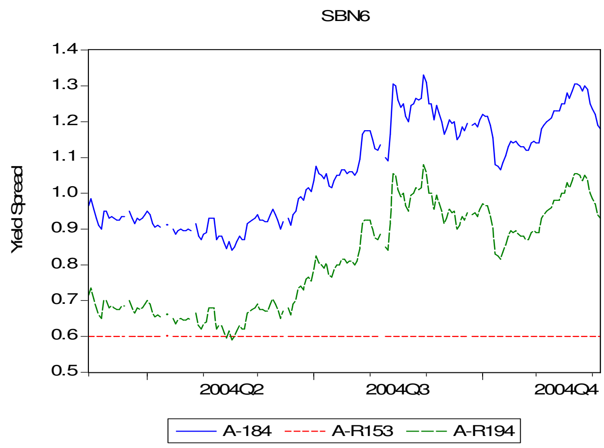


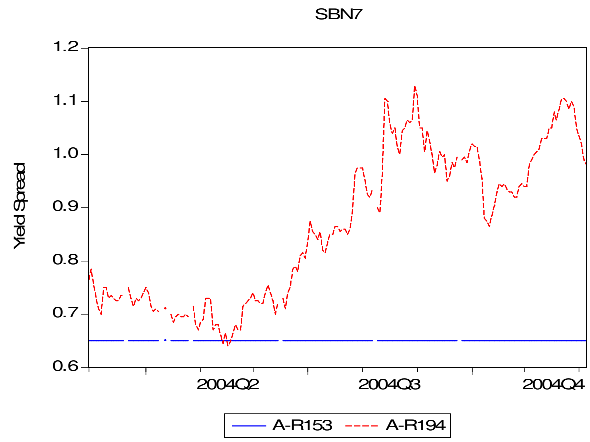


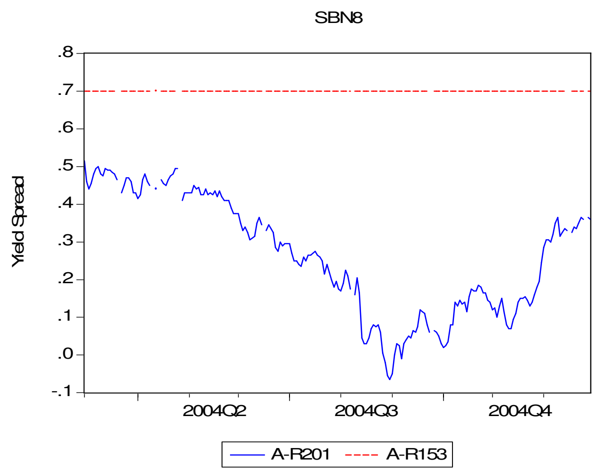



IV01
Yield Spread
2.0
1.8
1.6
1.4
1.2
1.0
2007Q3
2007Q4
2008Q1
A-R153
A-R201
A-R206

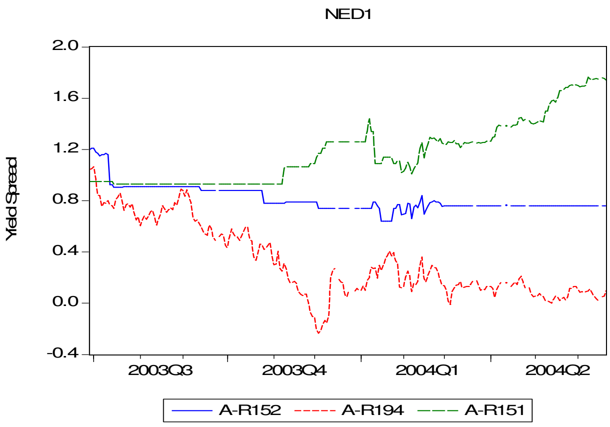

SBK4
Yield Spread
1.2
0.8
0.4
0.0
-0.4
-0.8
2004Q1
2004Q2
2004Q3
2004Q4
A-R151
A-R152

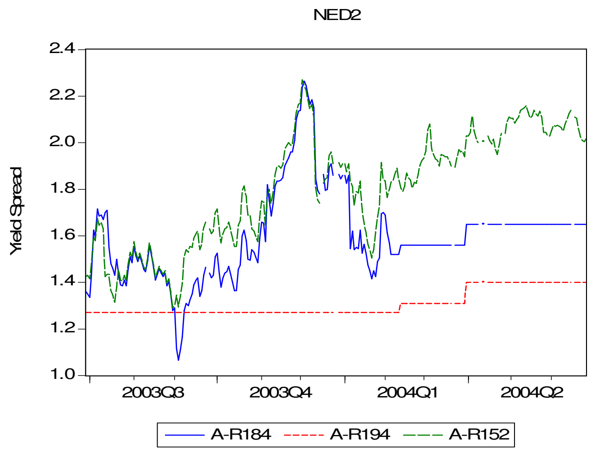

SBN6
Yield Spread
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
2004Q2
2004Q3
2004Q4
A-184
A-R153
A-R194

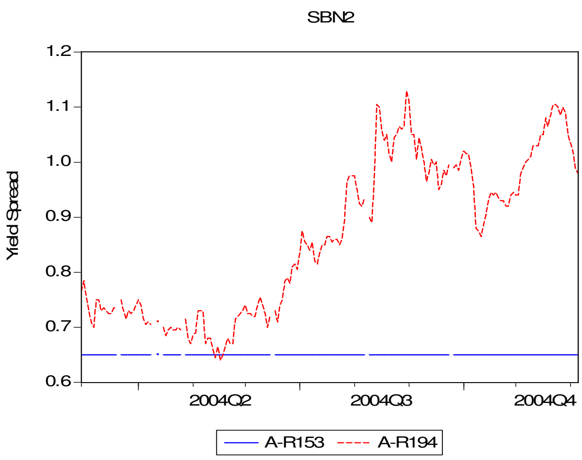

SBN7
Yield Spread
1.2
1.1
1.0
0.9
0.8
0.7
0.6
2004Q2
2004Q3
2004Q4
A-R153
A-R194

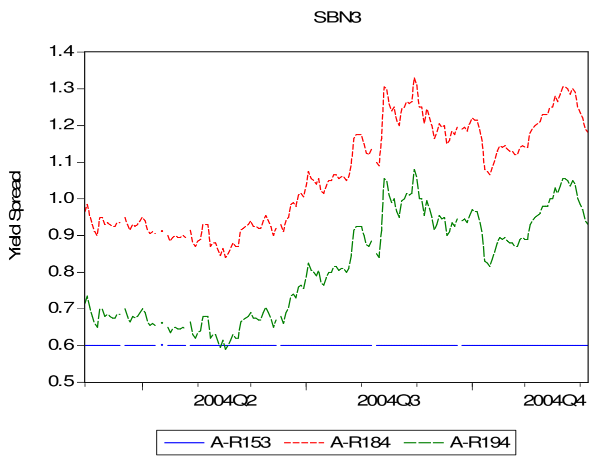

SBN8
Yield Spread
.8
.7
.6
.5
.4
.3
.2
.1
.0
-.1
2004Q2
2004Q3
2004Q4
A-R201
A-R153

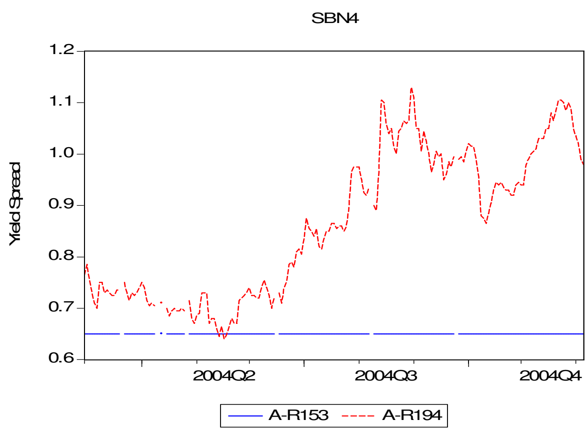
Corporate Callable | Government – Yield Spreads [-180; 180]

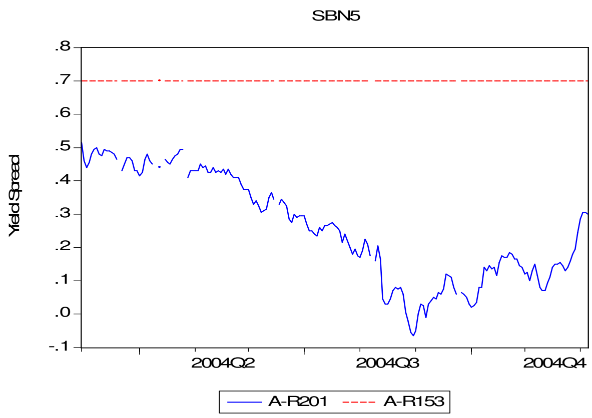


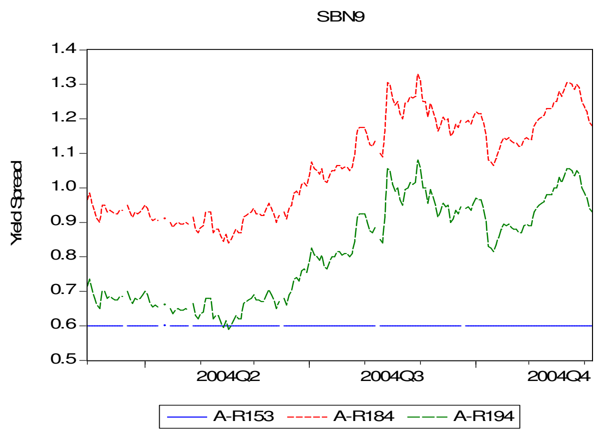


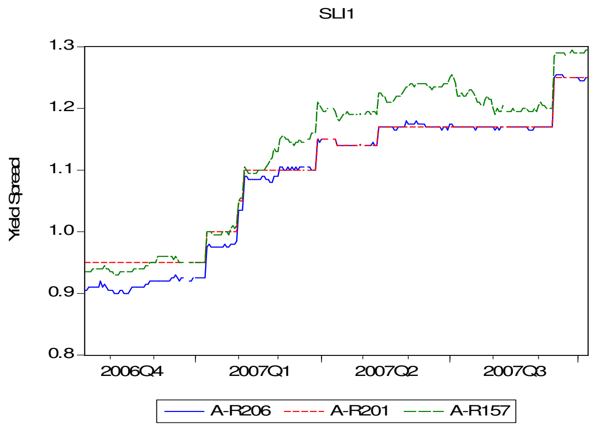


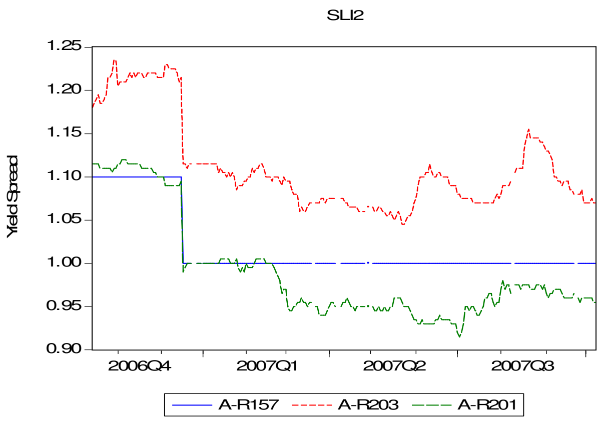




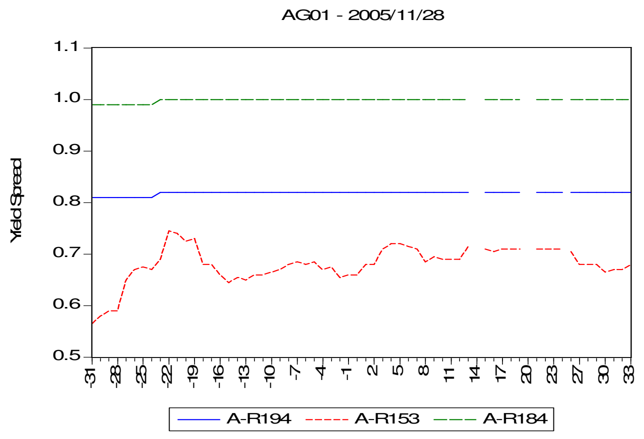


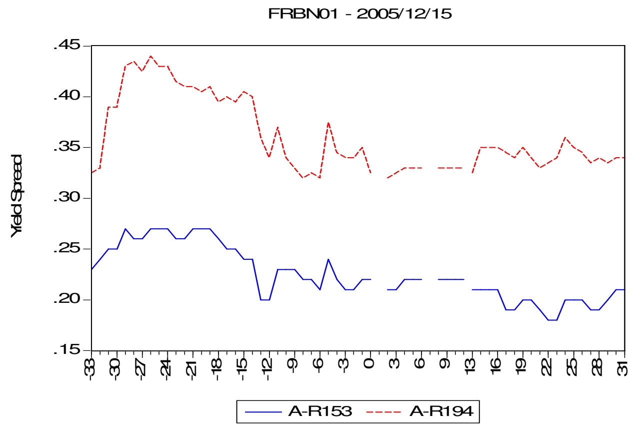

SBN9
Yield Spread
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
2004Q2
2004Q3
2004Q4
A-R153
A-R184
A-R194

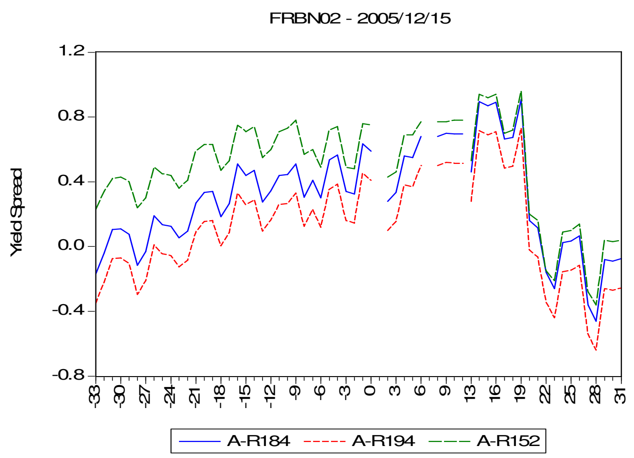

SLI1
Yield Spread
1.3
1.2
1.1
1.0
0.9
0.8
2006Q4
2007Q1
2007Q2
2007Q3
A-R206
A-R201
A-R157

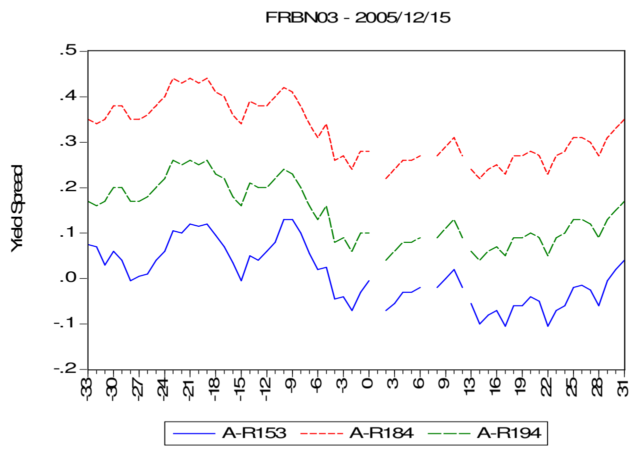

SLI2
Yield Spread
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
2006Q4
2007Q1
2007Q2
2007Q3
A-R157
A-R203
A-R201

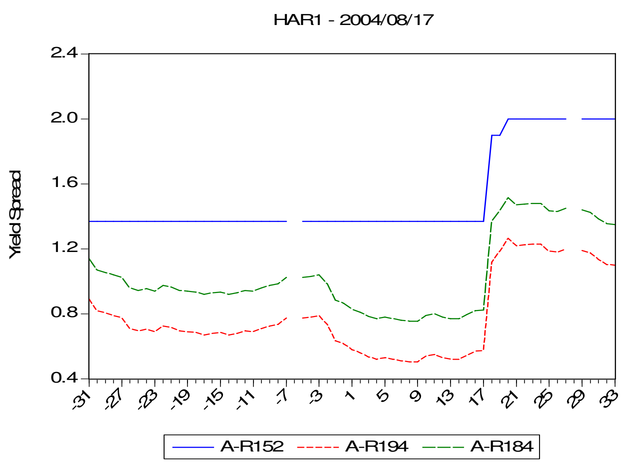
Corporate | Government – Yield Spreads [-45; 45]

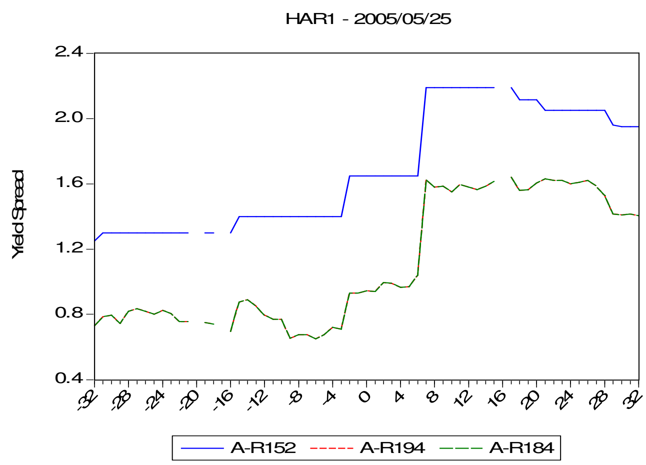


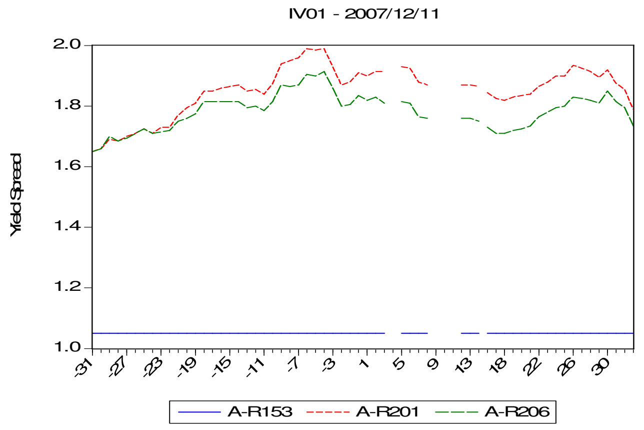


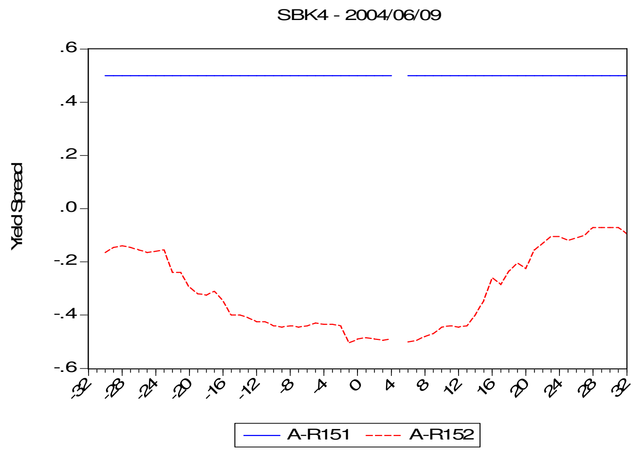


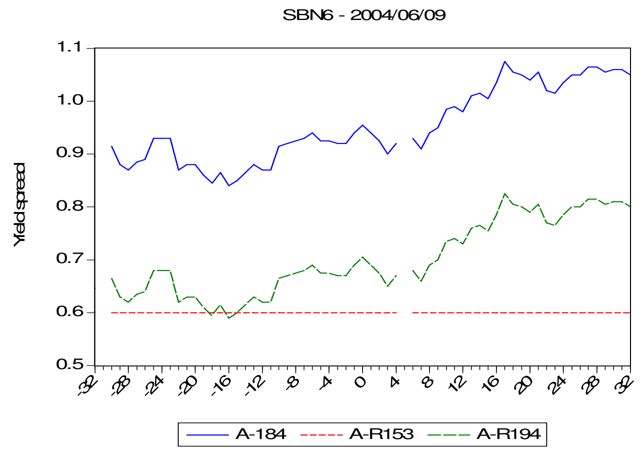


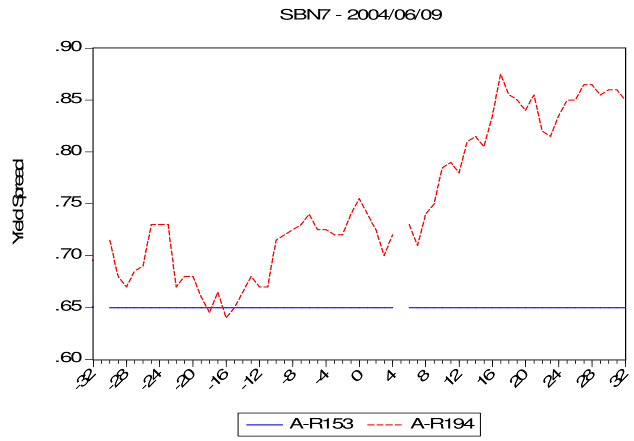


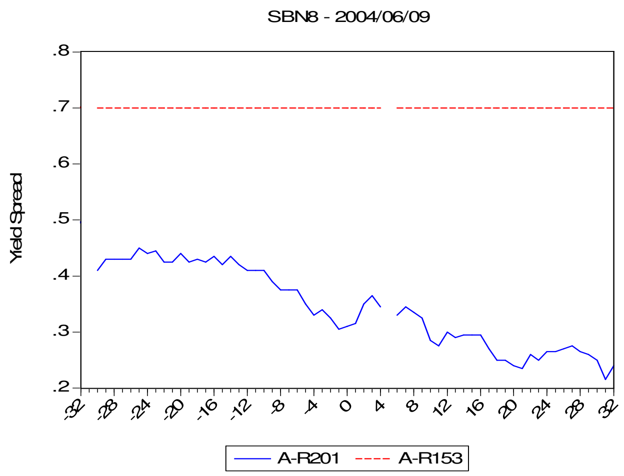



IV01 - 2007/12/11
Yield Spread
A-R153
A-R201
A-R206

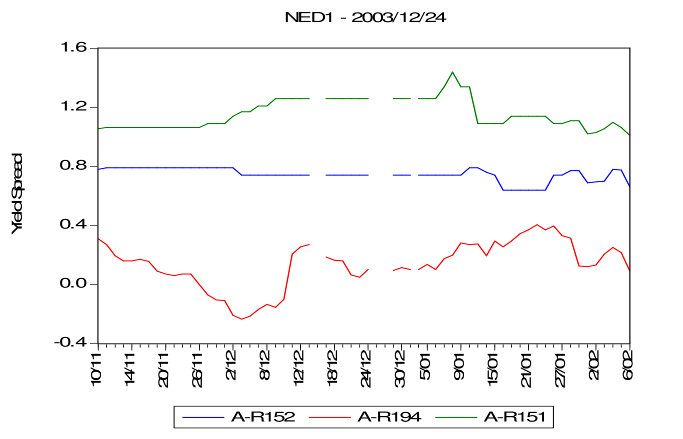

SBK4 - 2004/06/09
Yield Spread
A-R151
A-R152

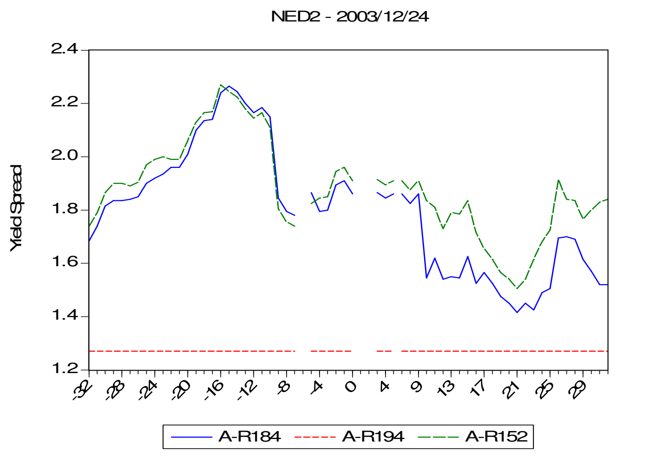

SBN6 - 2004/06/09
Yield spread
A-184
A-R153
A-R194

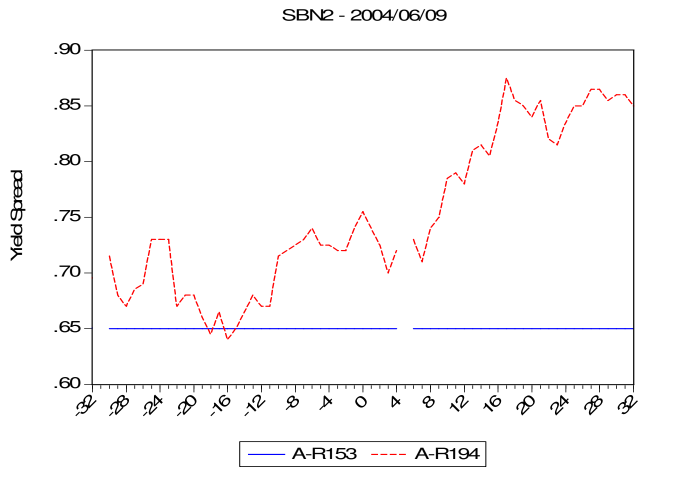

SBN7 - 2004/06/09
Yield Spread
A-R153
A-R194

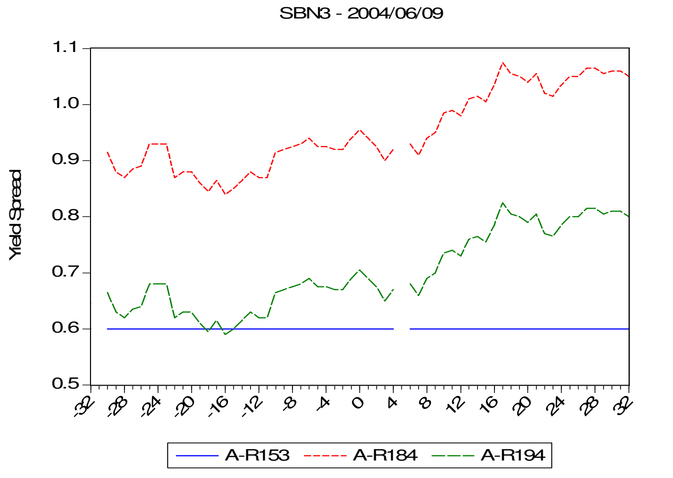

SBN8 - 2004/06/09
Yield Spread
A-R201
A-R153

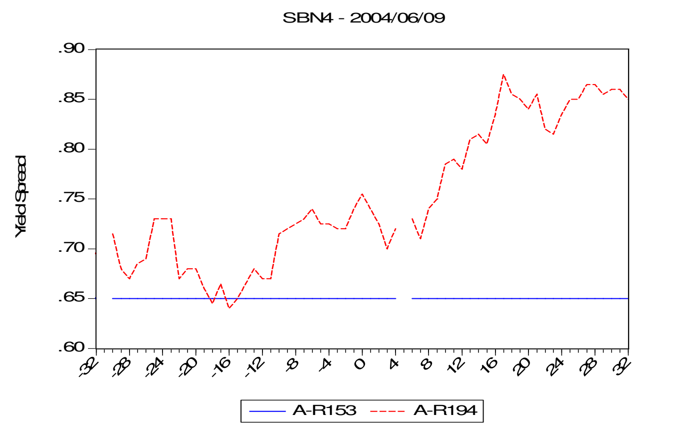
Corporate Callable | Government – Yield Spreads [-45; 45]

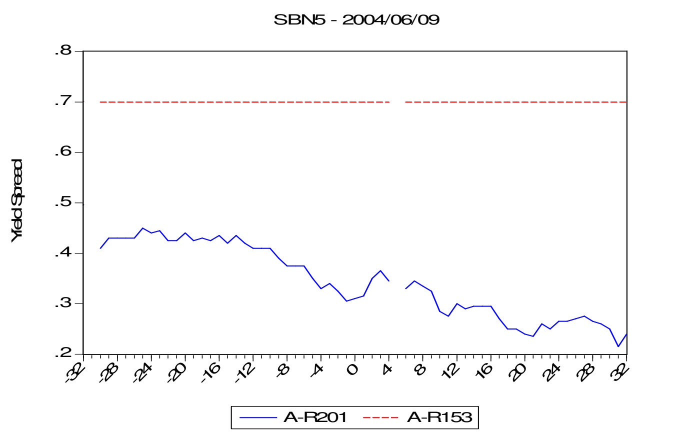


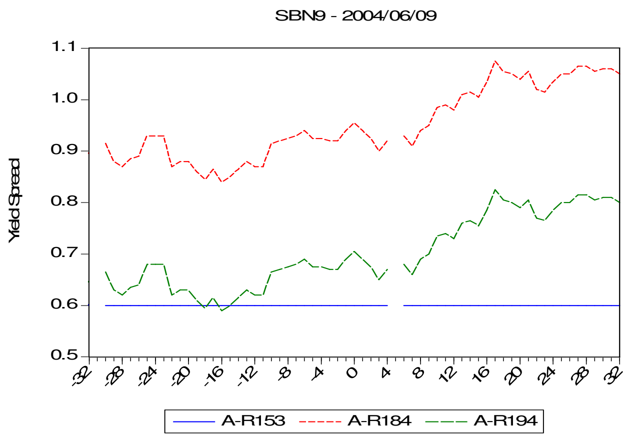


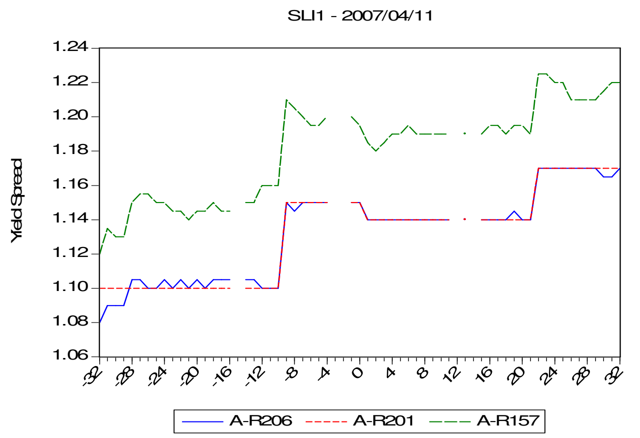


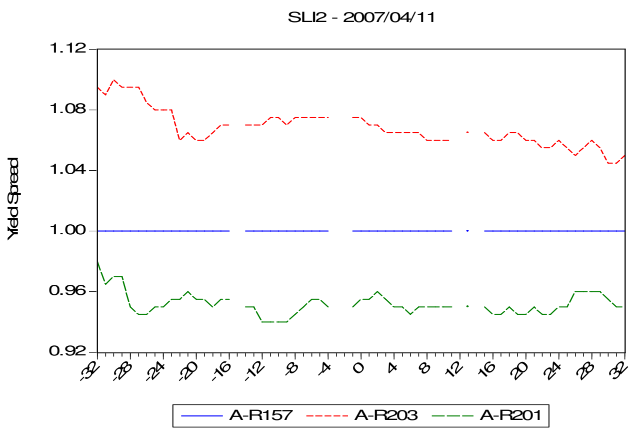






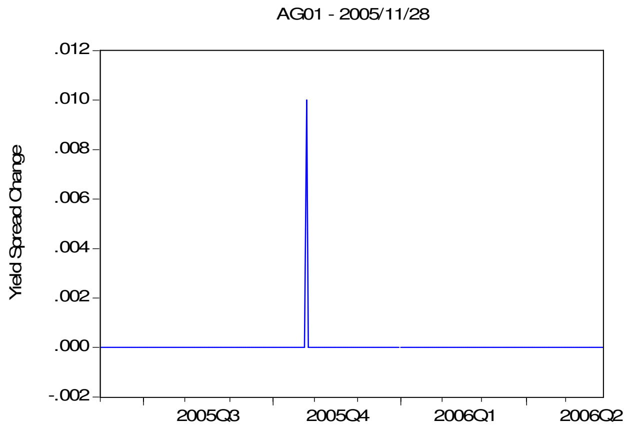

SBN9 - 2004/06/09
Yield Spread
A-R153
A-R184
A-R194

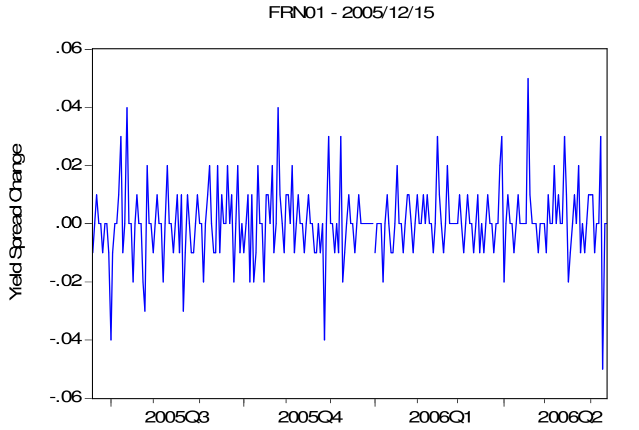

SLI1 - 2007/04/11
Yield Spread
A-R206
A-R201
A-R157

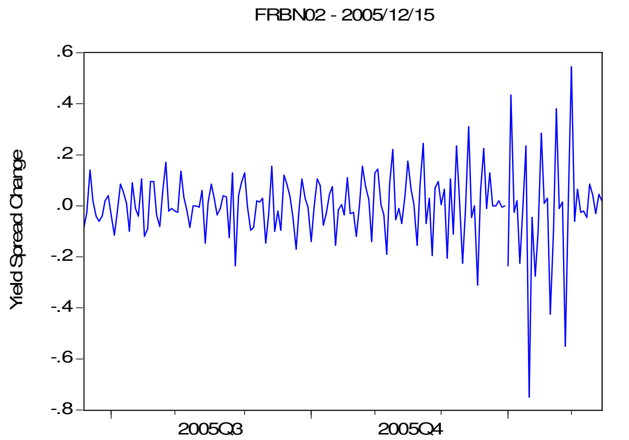

SLI2 - 2007/04/11
Yield Spread
A-R157
A-R203
A-R201

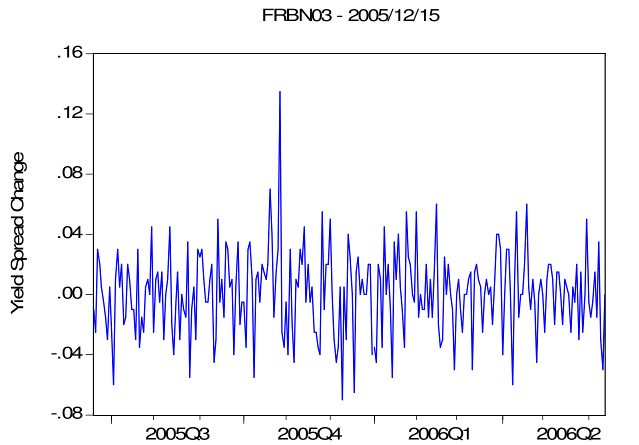
APPENDIX D

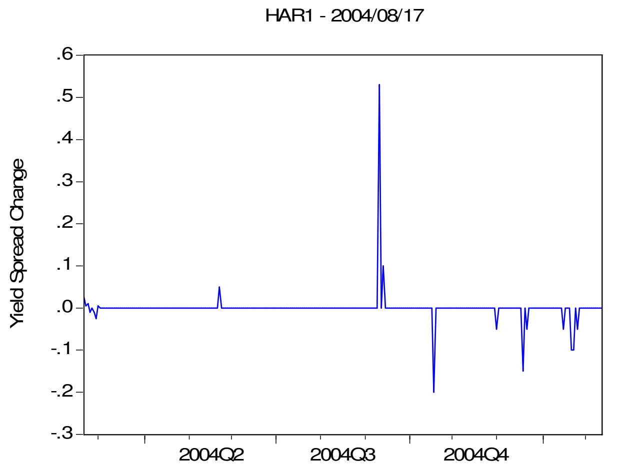
Corporate | Government – Yield Spread Change [-180; 180]

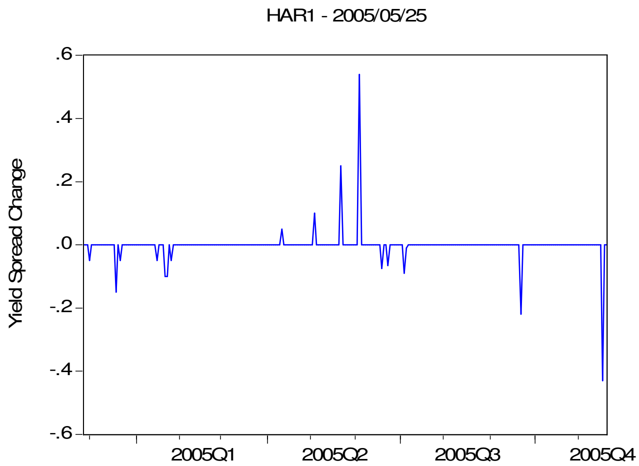


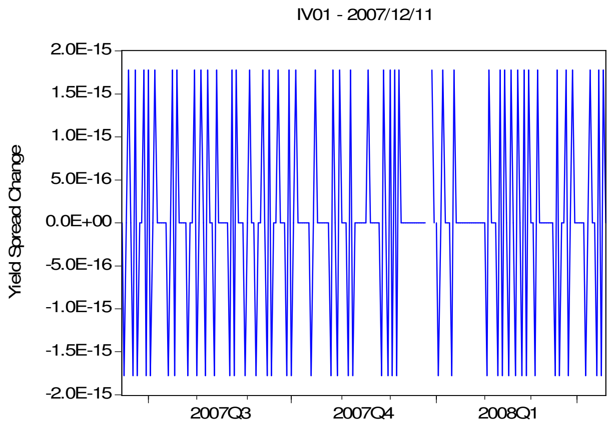


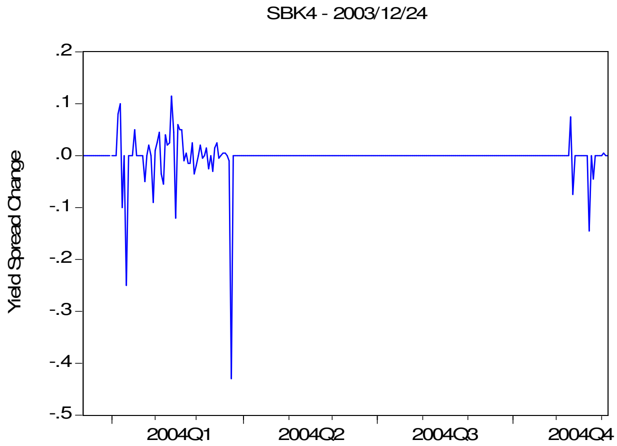


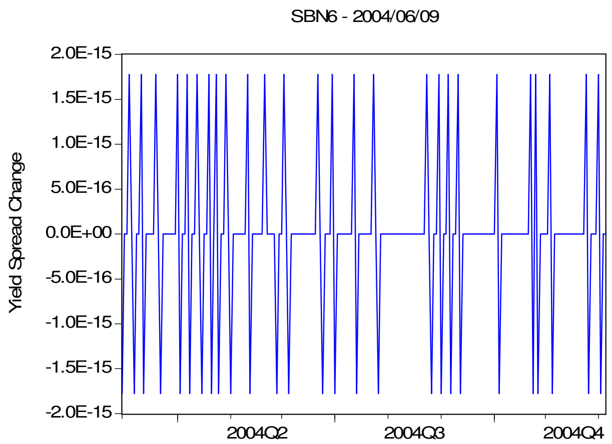


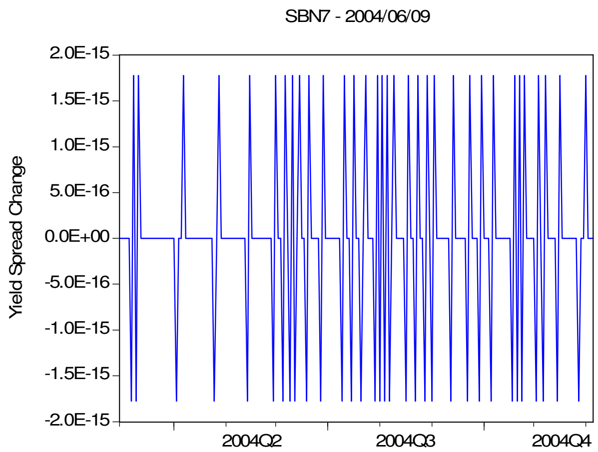


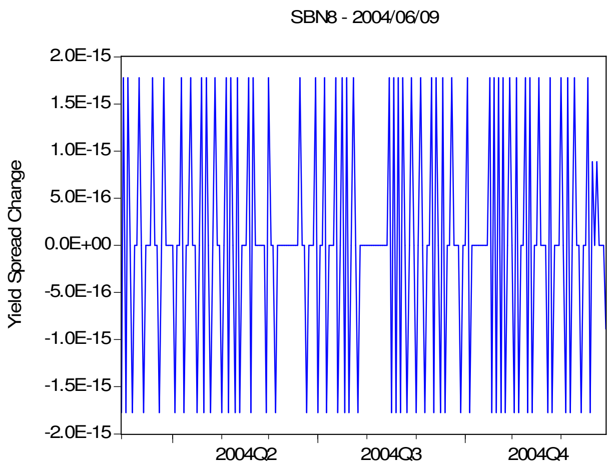



IV01 - 2007/12/11
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
2007Q3
2007Q4
2008Q1

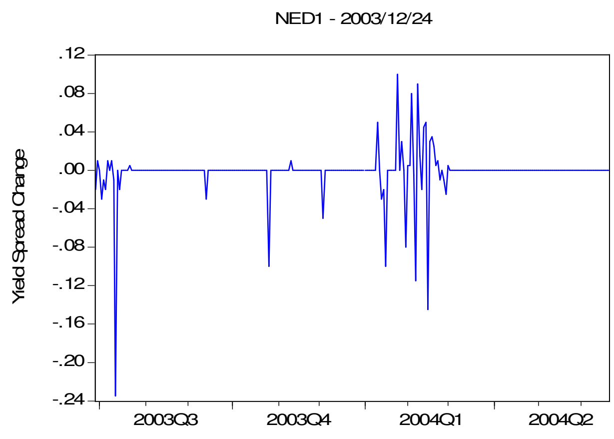

SBK4 - 2003/12/24
Yield Spread Change
.2
.1
.0
-.1
-.2
-.3
-.4
-.5
2004Q1
2004Q2
2004Q3
2004Q4

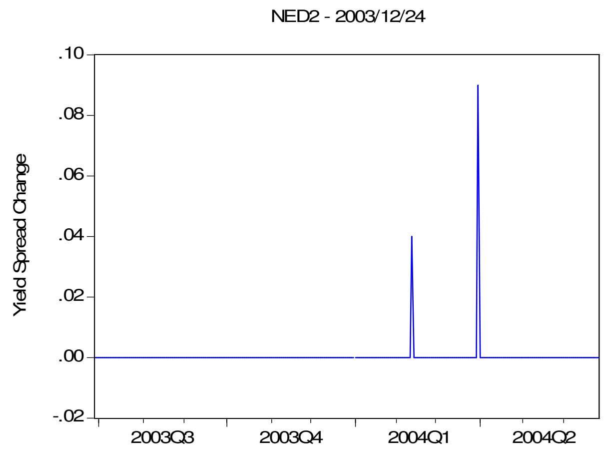

SBN6 - 2004/06/09
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
2004Q2
2004Q3
2004Q4

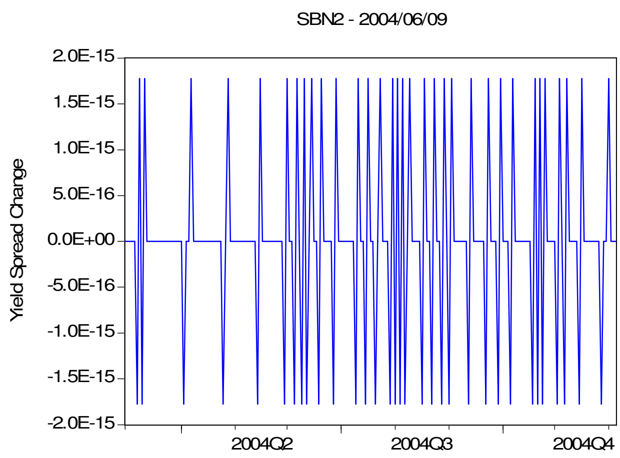

SBN7 - 2004/06/09
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
2004Q2
2004Q3
2004Q4

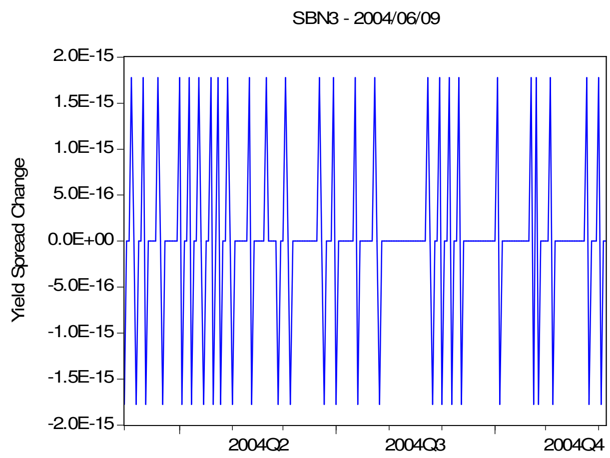

SBN8 - 2004/06/09
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
2004Q2
2004Q3
2004Q4

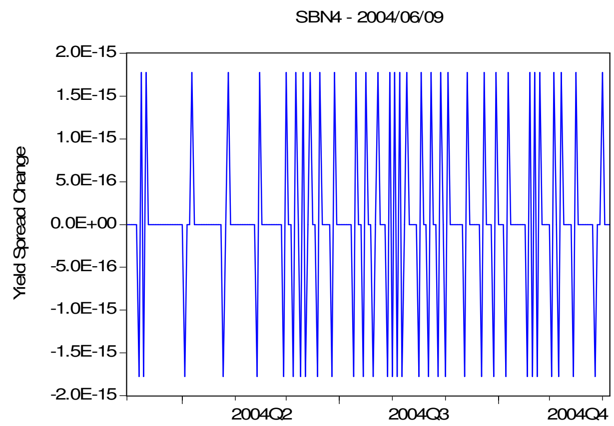
Corporate Callable | Government – Yield Spread Change [-180; 180]

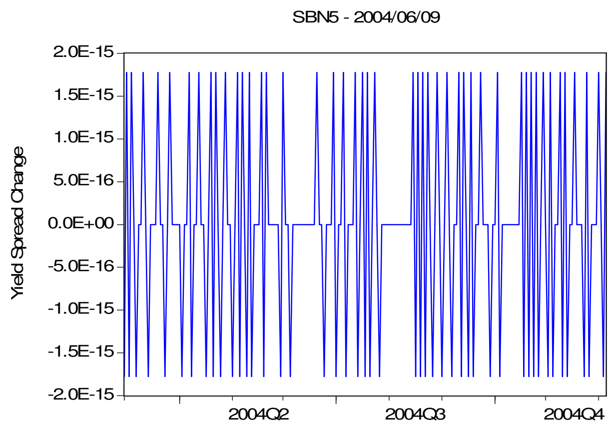


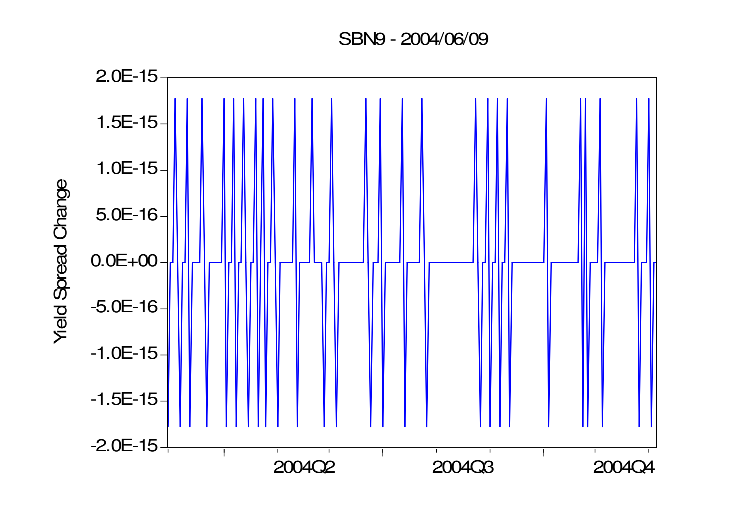


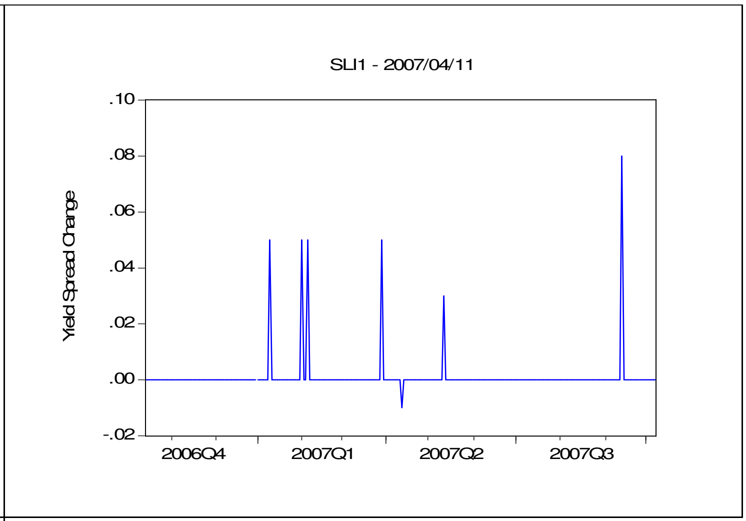


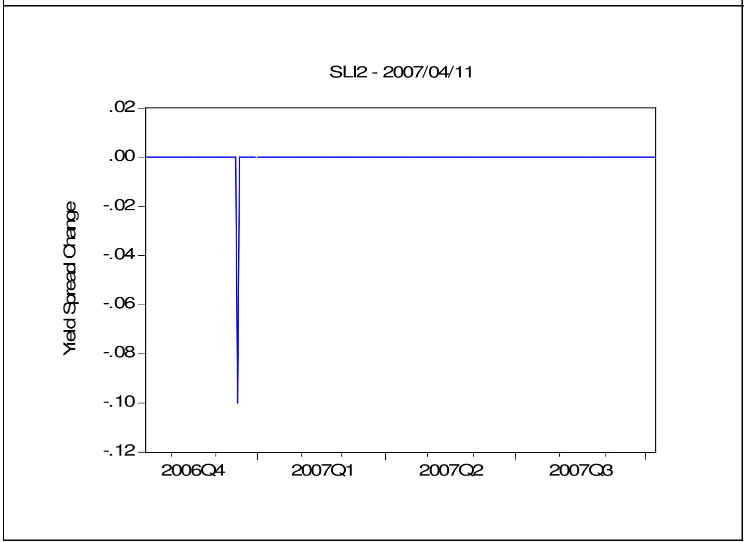




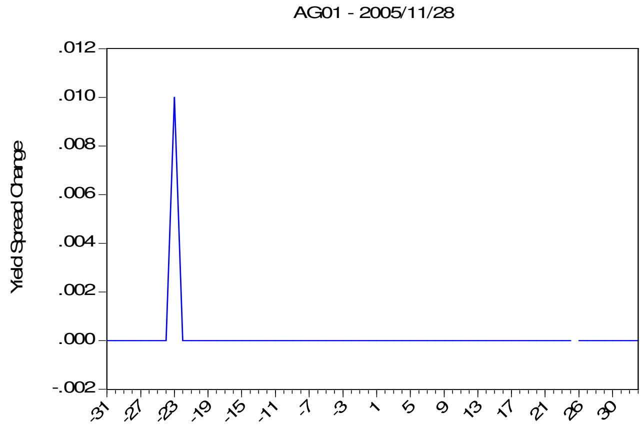


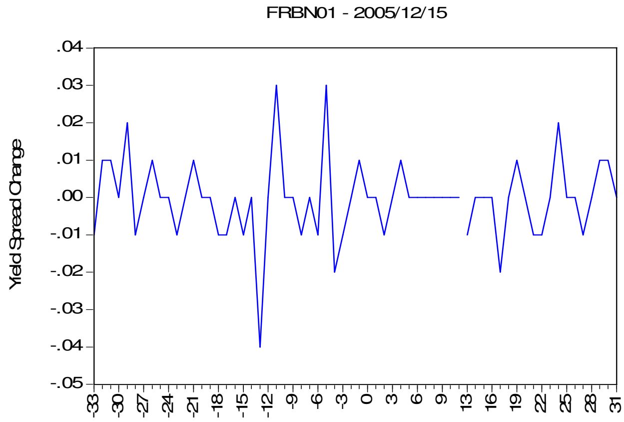

SBN9 - 2004/06/09
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
2004Q2
2004Q3
2004Q4

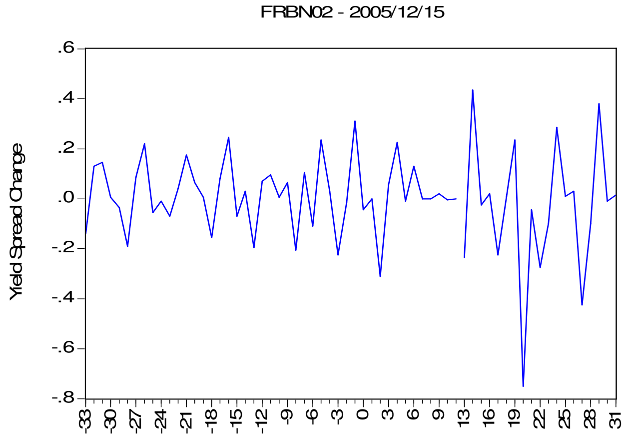

SLI1 - 2007/04/11
Yield Spread Change
.10
.08
.06
.04
.02
.00
-.02
2006Q4
2007Q1
2007Q2
2007Q3

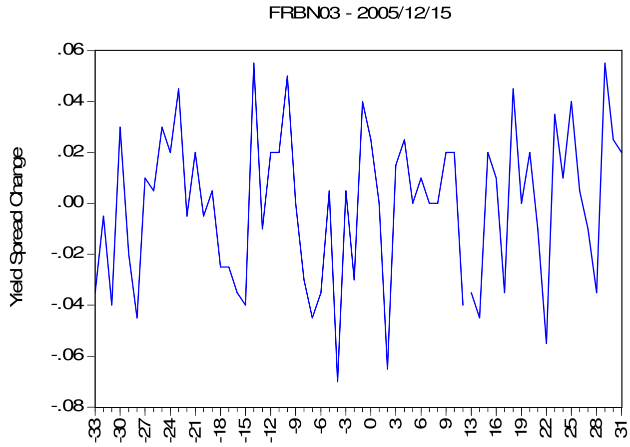

SLI2 - 2007/04/11
Yield Spread Change
.02
.00
-.02
-.04
-.06
-.08
-.10
-.12
2006Q4
2007Q1
2007Q2
2007Q3

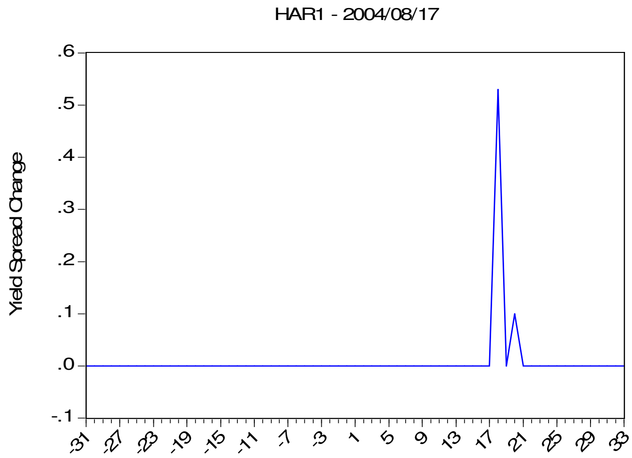
Corporate | Government – Yield Spread Change [-45; 45]

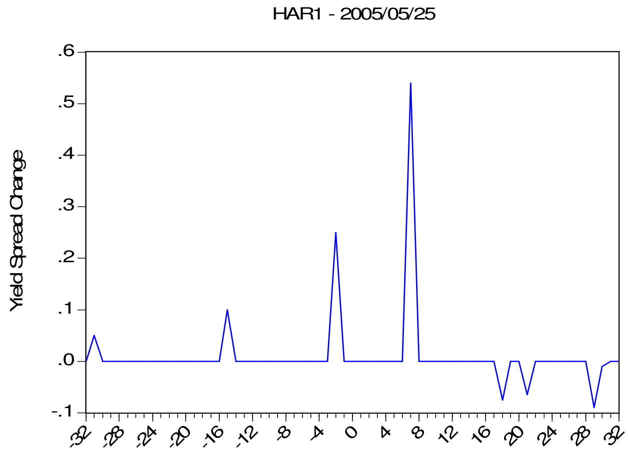


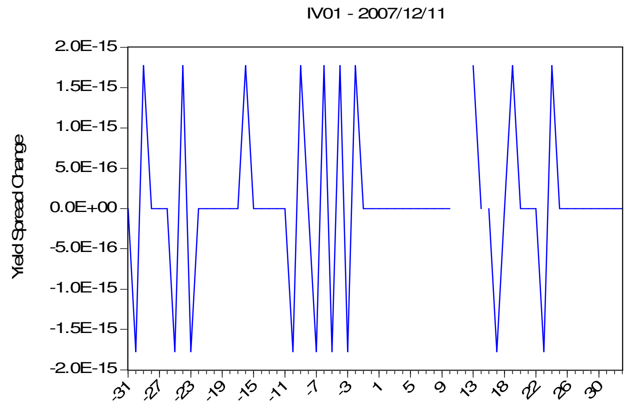


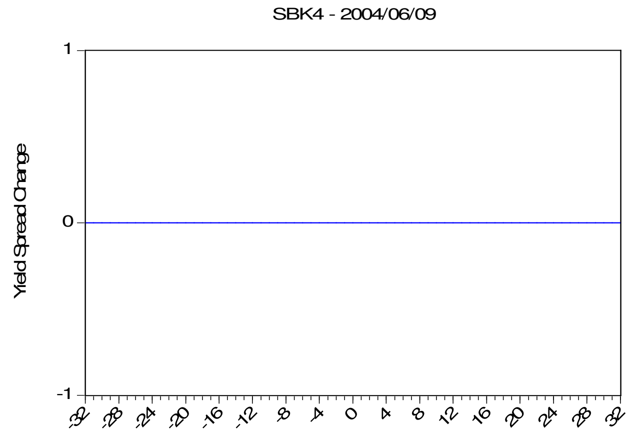


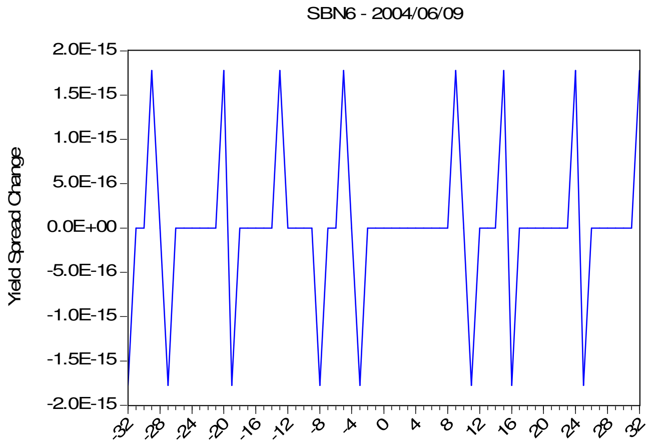


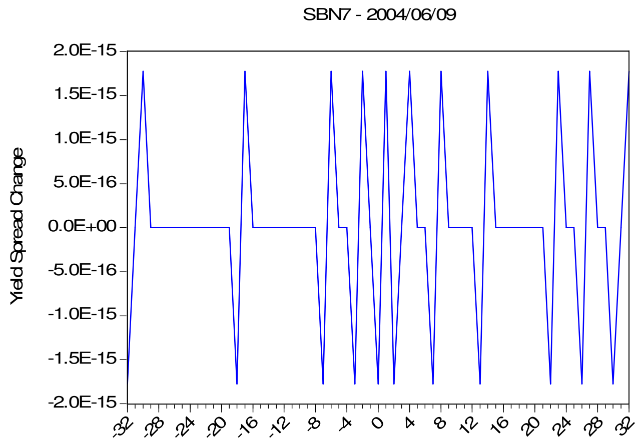


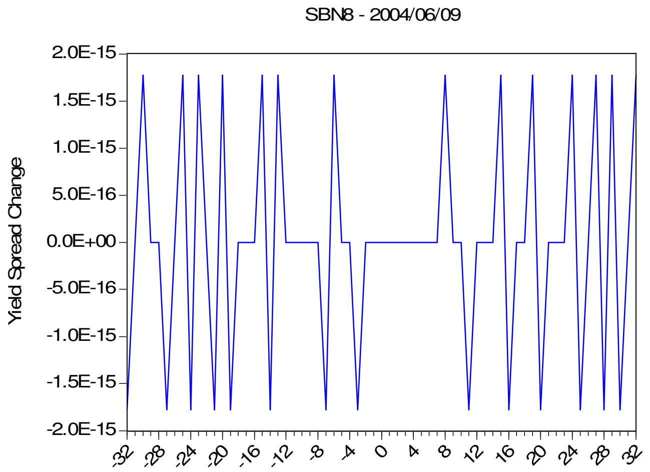



IV01 - 2007/12/11
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
-31 -27 -23 -19 -15 -11 -7 -3 1 5 9 13 18 22 26 30

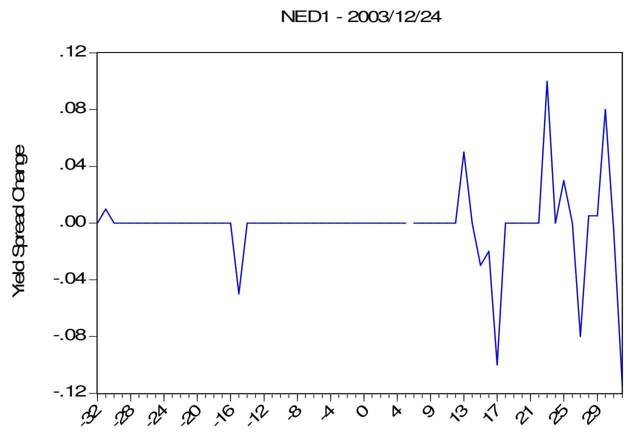

SBK4 - 2004/06/09
Yield Spread Change
1
0
-1
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32

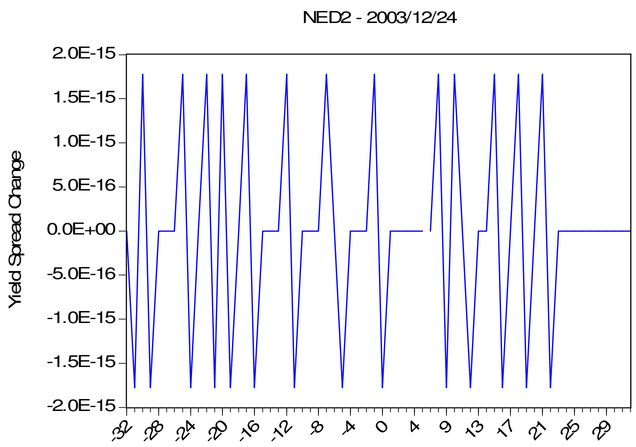

SBN6 - 2004/06/09
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32

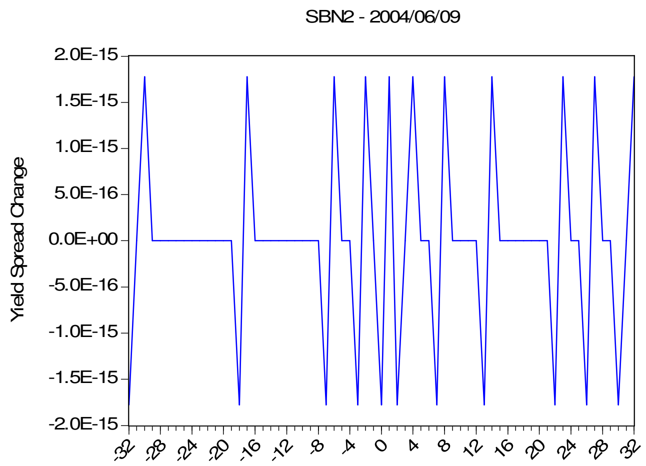

SBN7 - 2004/06/09
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32

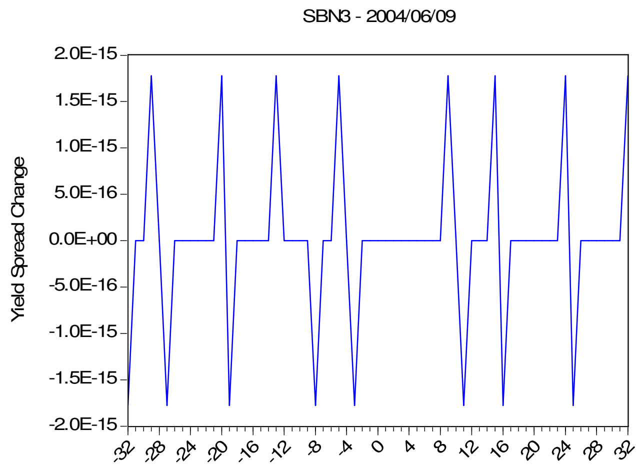

SBN8 - 2004/06/09
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32

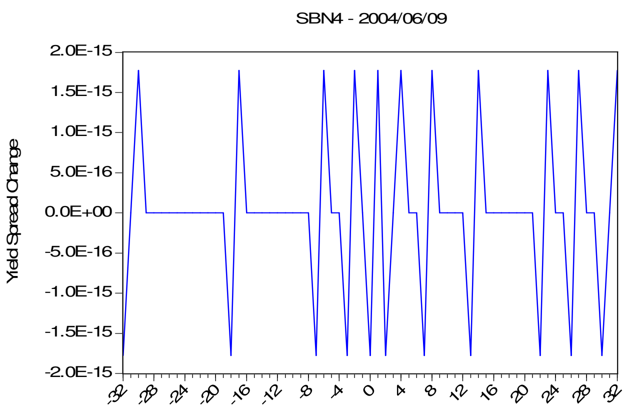
Corporate Callable | Government – Yield Spread Change [-45; 45]

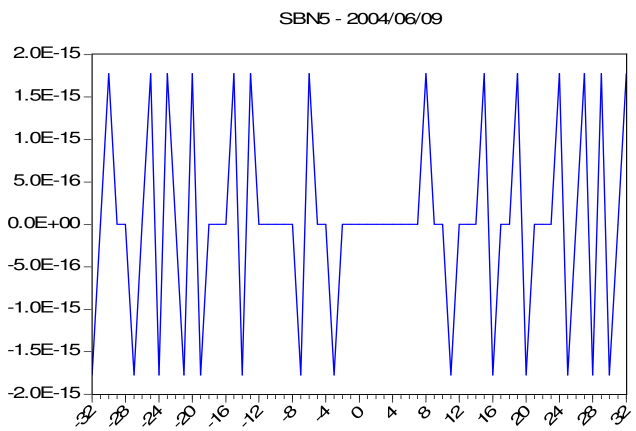


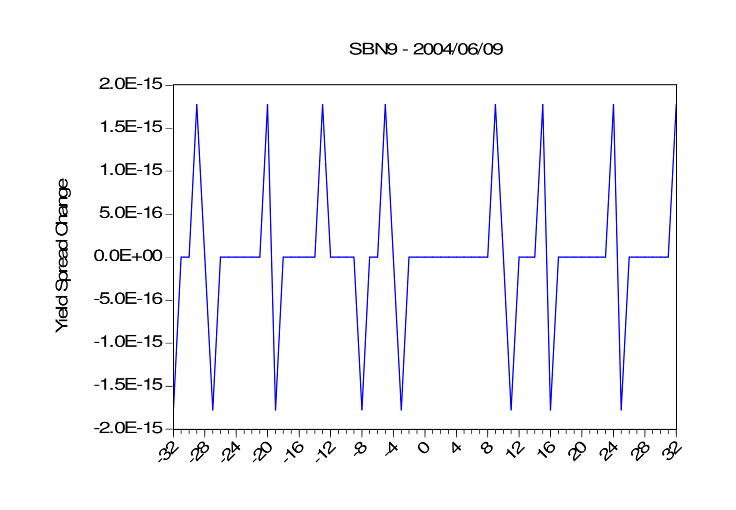


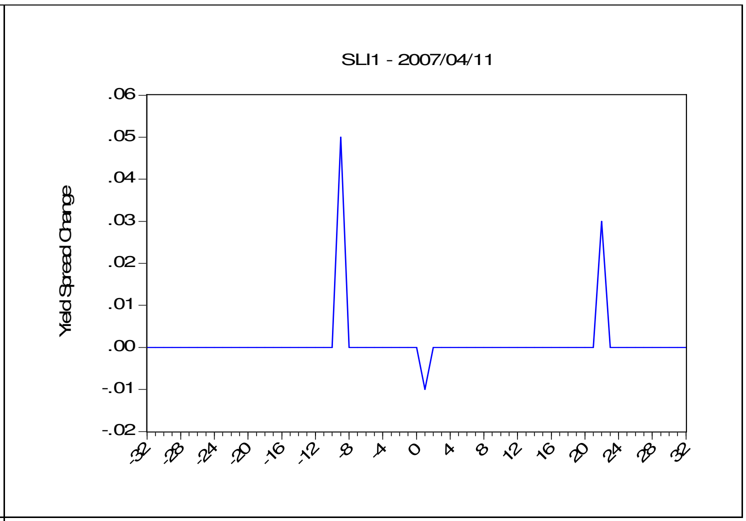


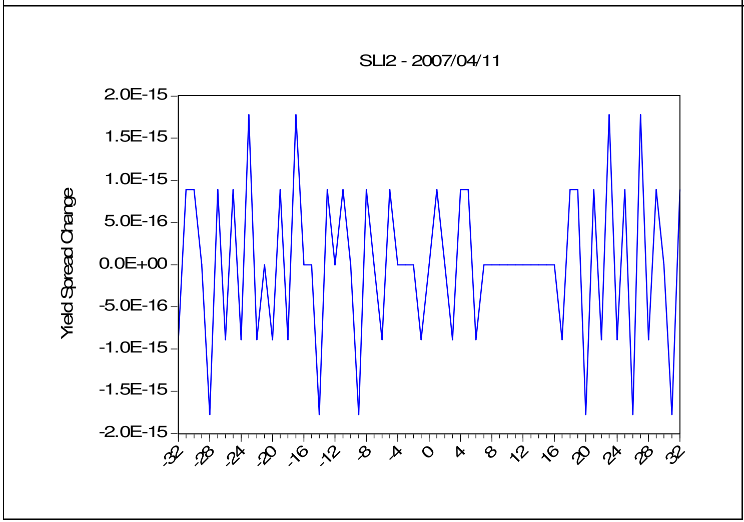






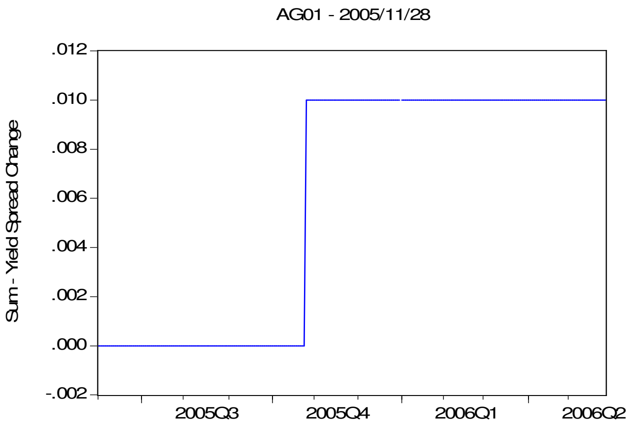

SBN9 - 2004/06/09
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
-32
-28
-24
-20
-16
-12
-8
-4
0
4
8
12
16
20
24
28
32

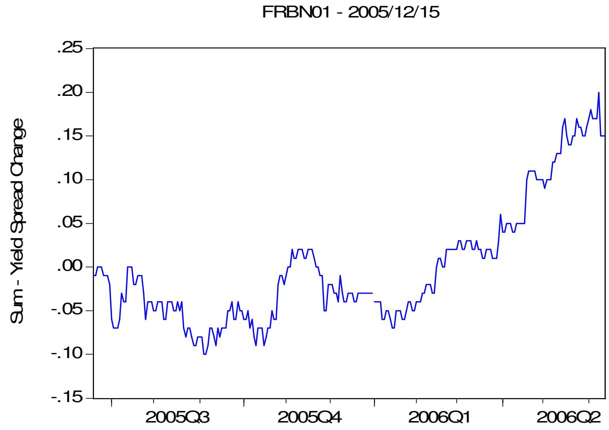

SLI1 - 2007/04/11
Yield Spread Change
.06
.05
.04
.03
.02
.01
.00
-.01
-.02
-32
-28
-24
-20
-16
-12
-8
-4
0
4
8
12
16
20
24
28
32

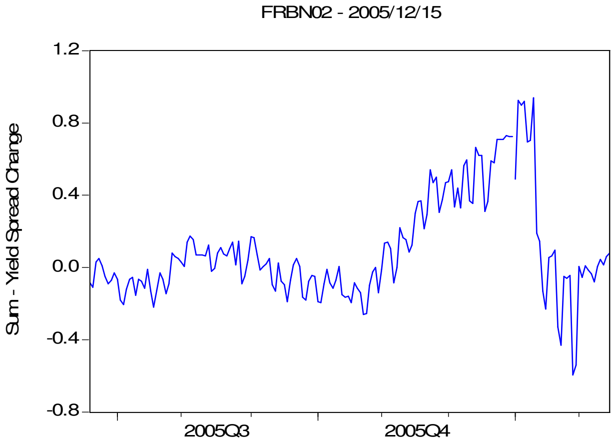

SLI2 - 2007/04/11
Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
-32
-28
-24
-20
-16
-12
-8
-4
0
4
8
12
16
20
24
28
32

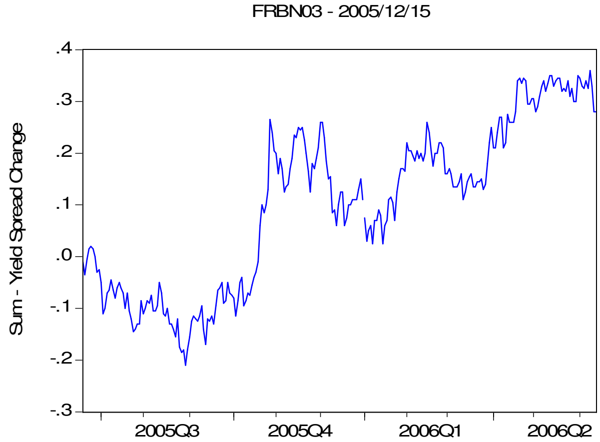
APPENDIX E

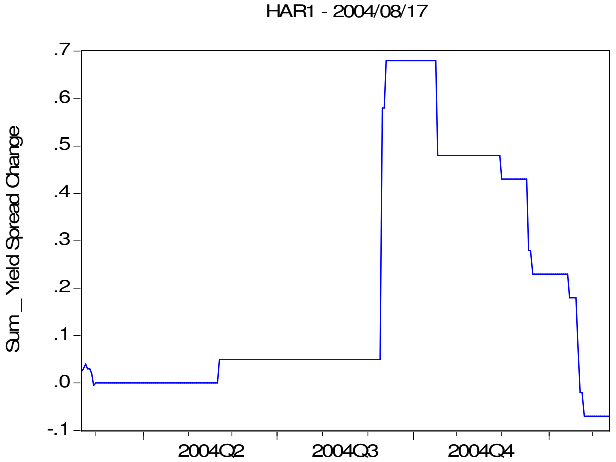
Corporate | Government – Summation of Yield Spread Change [-180; 180]

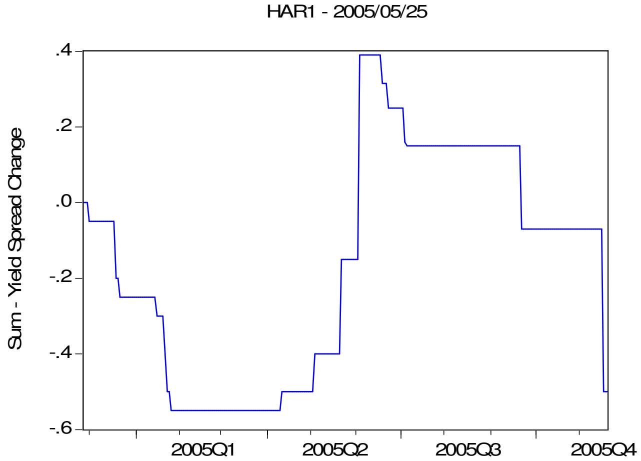


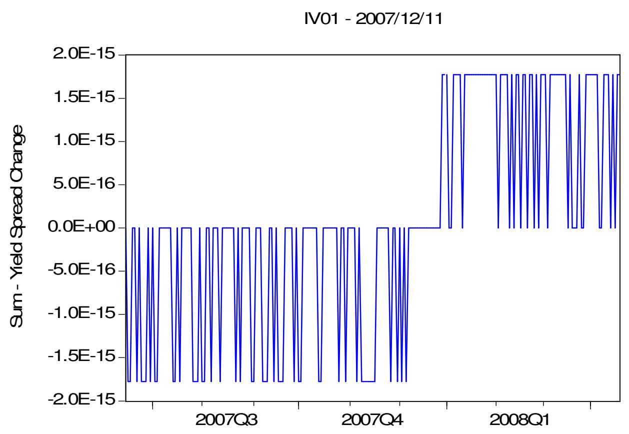


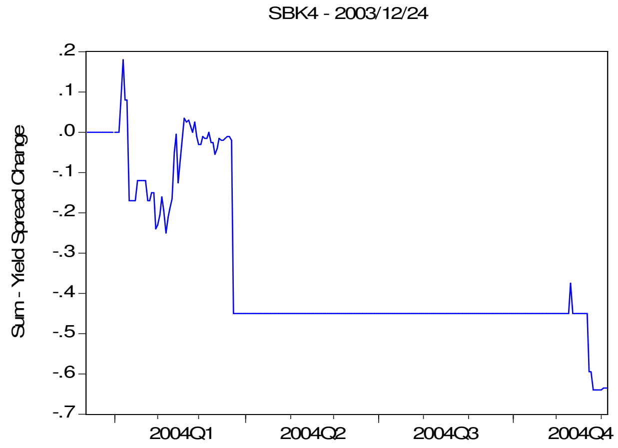


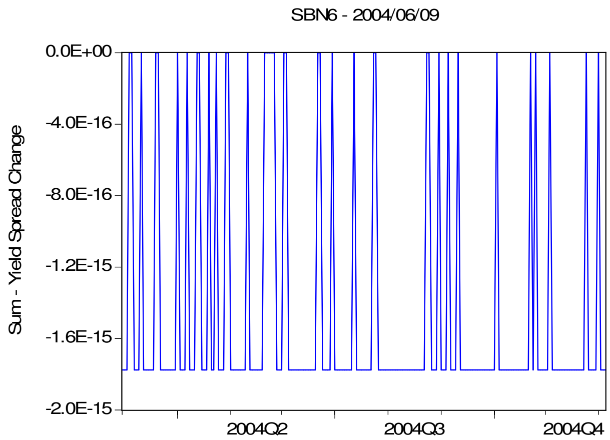


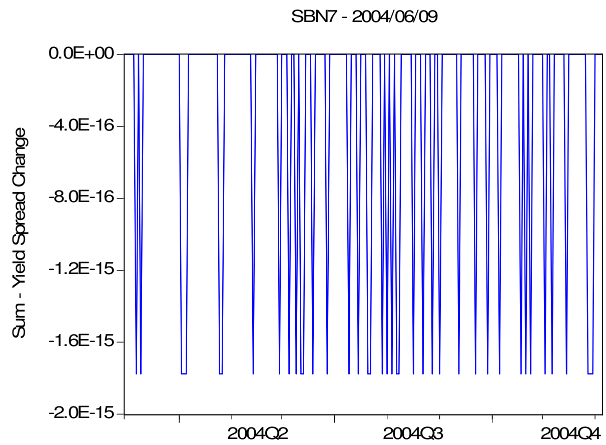


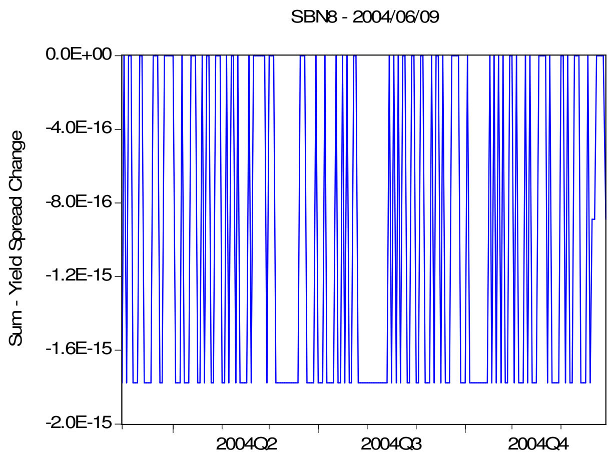



IV01 - 2007/12/11
Sum - Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
2007Q3
2007Q4
2008Q1

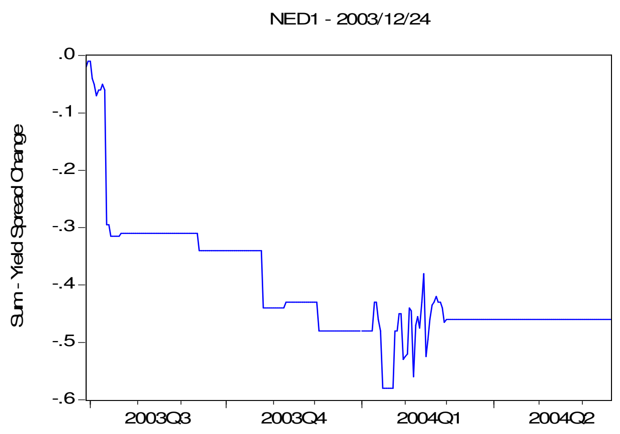

SBK4 - 2003/12/24
Sum - Yield Spread Change
.2
.1
.0
-.1
-.2
-.3
-.4
-.5
-.6
-.7
2004Q1
2004Q2
2004Q3
2004Q4

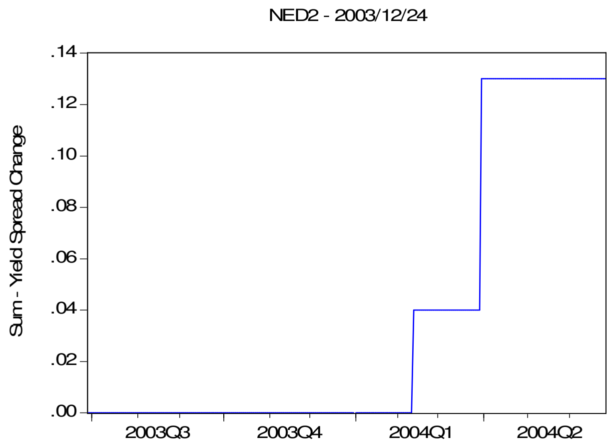

SBN6 - 2004/06/09
Sum - Yield Spread Change
0.0E+00
-4.0E-16
-8.0E-16
-1.2E-15
-1.6E-15
-2.0E-15
2004Q2
2004Q3
2004Q4

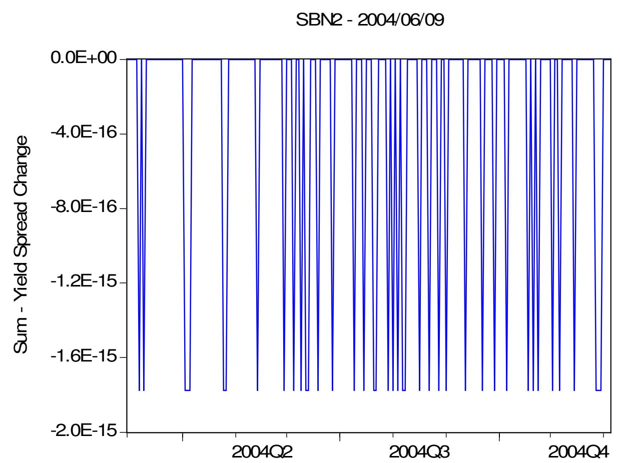

SBN7 - 2004/06/09
Sum - Yield Spread Change
0.0E+00
-4.0E-16
-8.0E-16
-1.2E-15
-1.6E-15
-2.0E-15
2004Q2
2004Q3
2004Q4

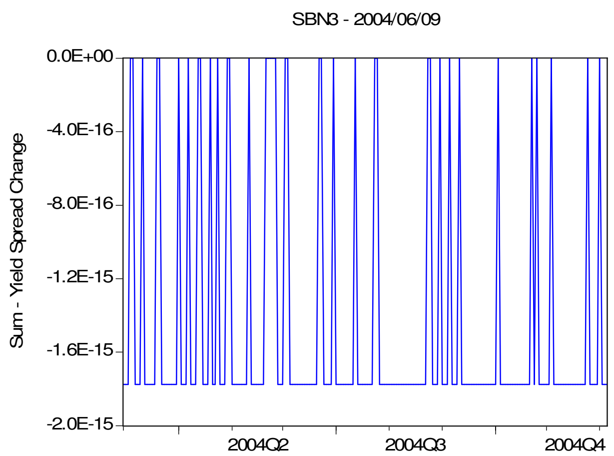

SBN8 - 2004/06/09
Sum - Yield Spread Change
0.0E+00
-4.0E-16
-8.0E-16
-1.2E-15
-1.6E-15
-2.0E-15
2004Q2
2004Q3
2004Q4

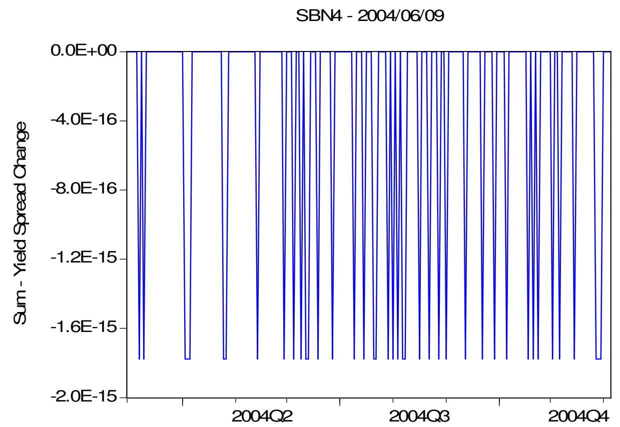
Corporate Callable | Government – Summation of Yield Spread Change [-180; 180]

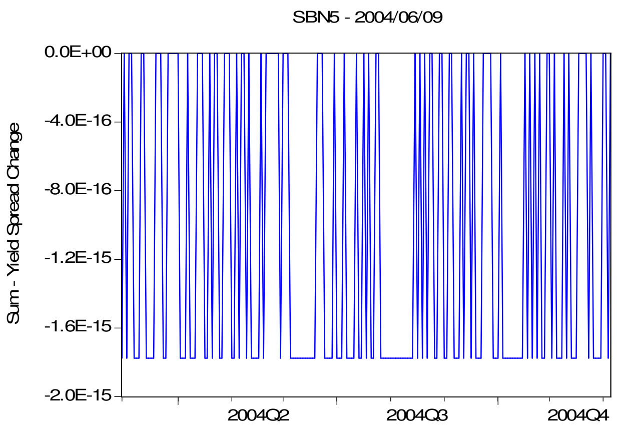


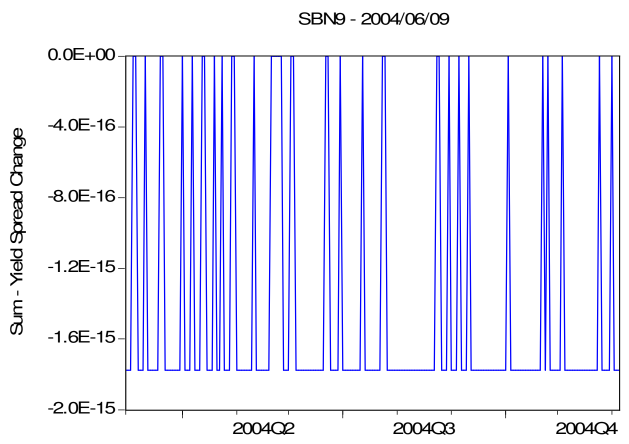


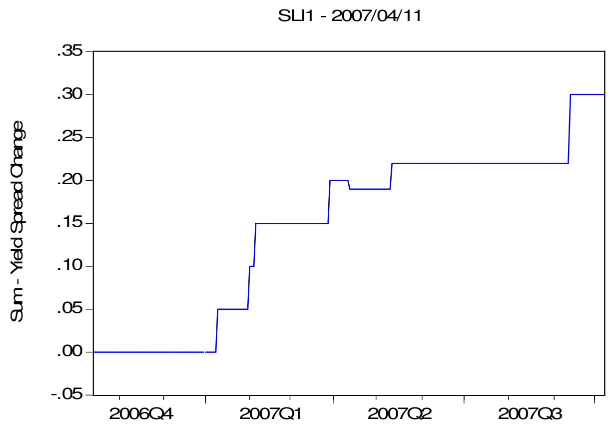


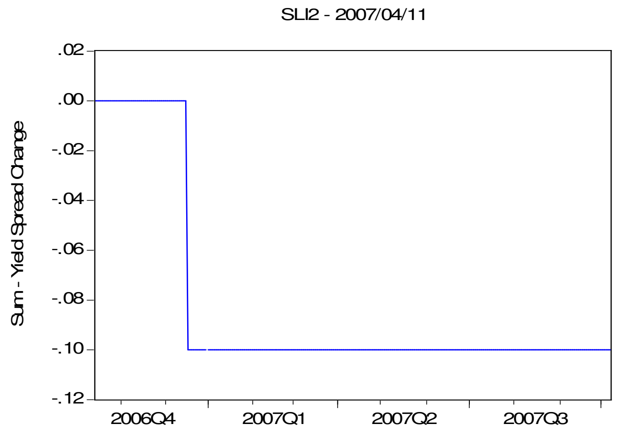




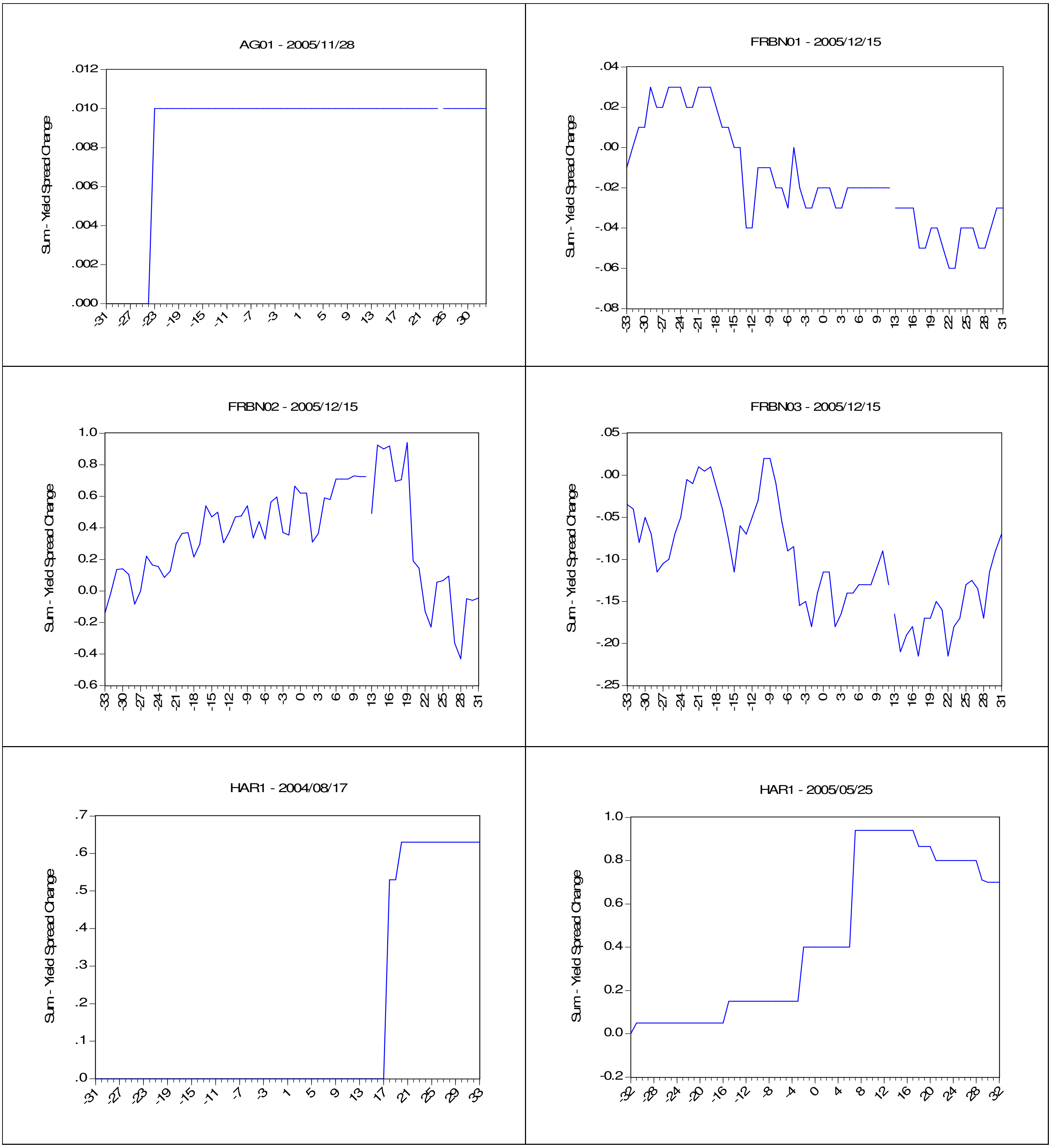


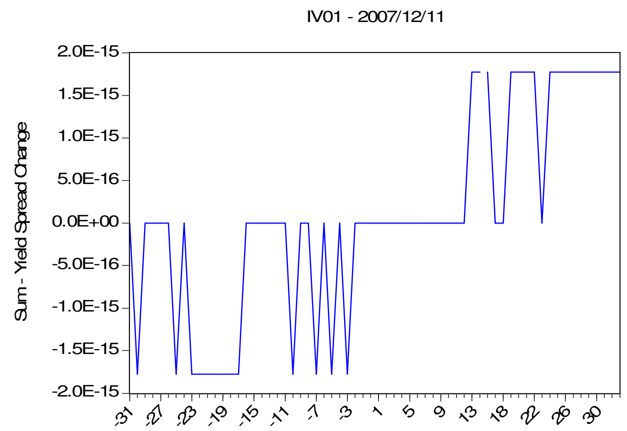

SBN9 - 2004/06/09
Sum - Yield Spread Change
0.0E+00
-4.0E-16
-8.0E-16
-1.2E-15
-1.6E-15
-2.0E-15
2004Q2
2004Q3
2004Q4

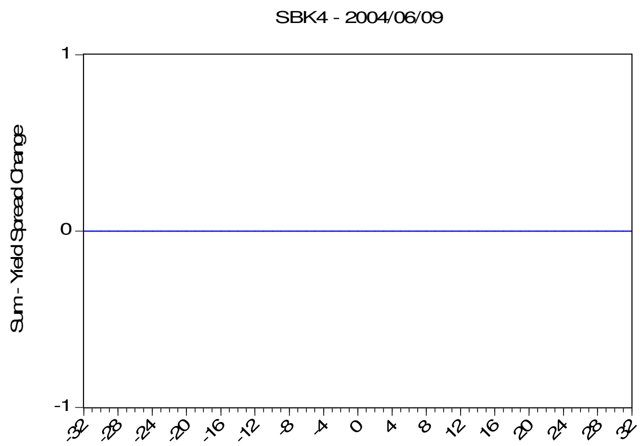

SLI1 - 2007/04/11
Sum - Yield Spread Change
.35
.30
.25
.20
.15
.10
.05
.00
-.05
2006Q4
2007Q1
2007Q2
2007Q3

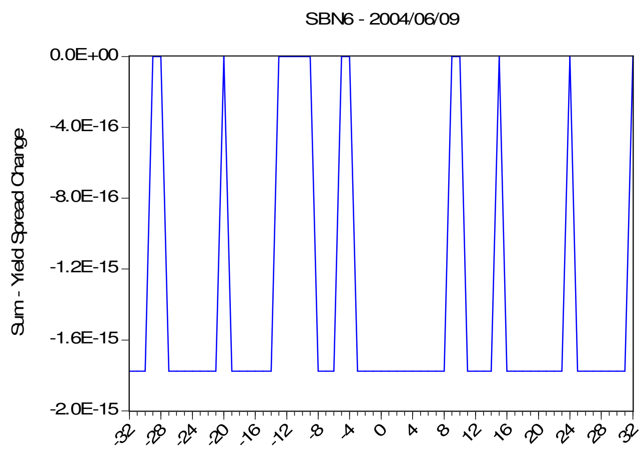

SLI2 - 2007/04/11
Sum - Yield Spread Change
.02
.00
-.02
-.04
-.06
-.08
-.10
-.12
2006Q4
2007Q1
2007Q2
2007Q3

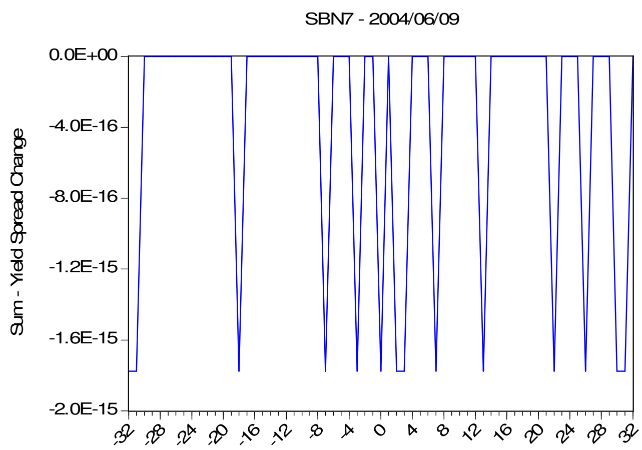
Corporate | Government – Summation of Yield Spread Change [-45; 45]




IV01 - 2007/12/11
Sum - Yield Spread Change
2.0E-15
1.5E-15
1.0E-15
5.0E-16
0.0E+00
-5.0E-16
-1.0E-15
-1.5E-15
-2.0E-15
-31 -27 -23 -19 -15 -11 -7 -3 1 5 9 13 18 22 26 30


SBK4 - 2004/06/09
Sum - Yield Spread Change
1
0
-1
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32


SBN6 - 2004/06/09
Sum - Yield Spread Change
0.0E+00
-4.0E-16
-8.0E-16
-1.2E-15
-1.6E-15
-2.0E-15
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32


SBN7 - 2004/06/09
Sum - Yield Spread Change
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-8.0E-16
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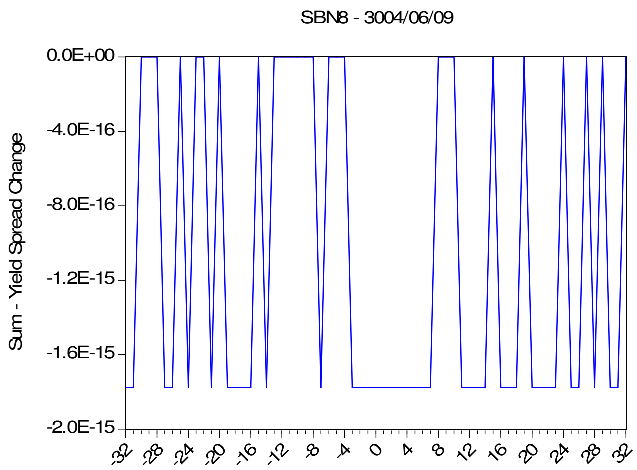
-1.6E-15
-2.0E-15
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32


SBN8 - 3004/06/09
Sum - Yield Spread Change
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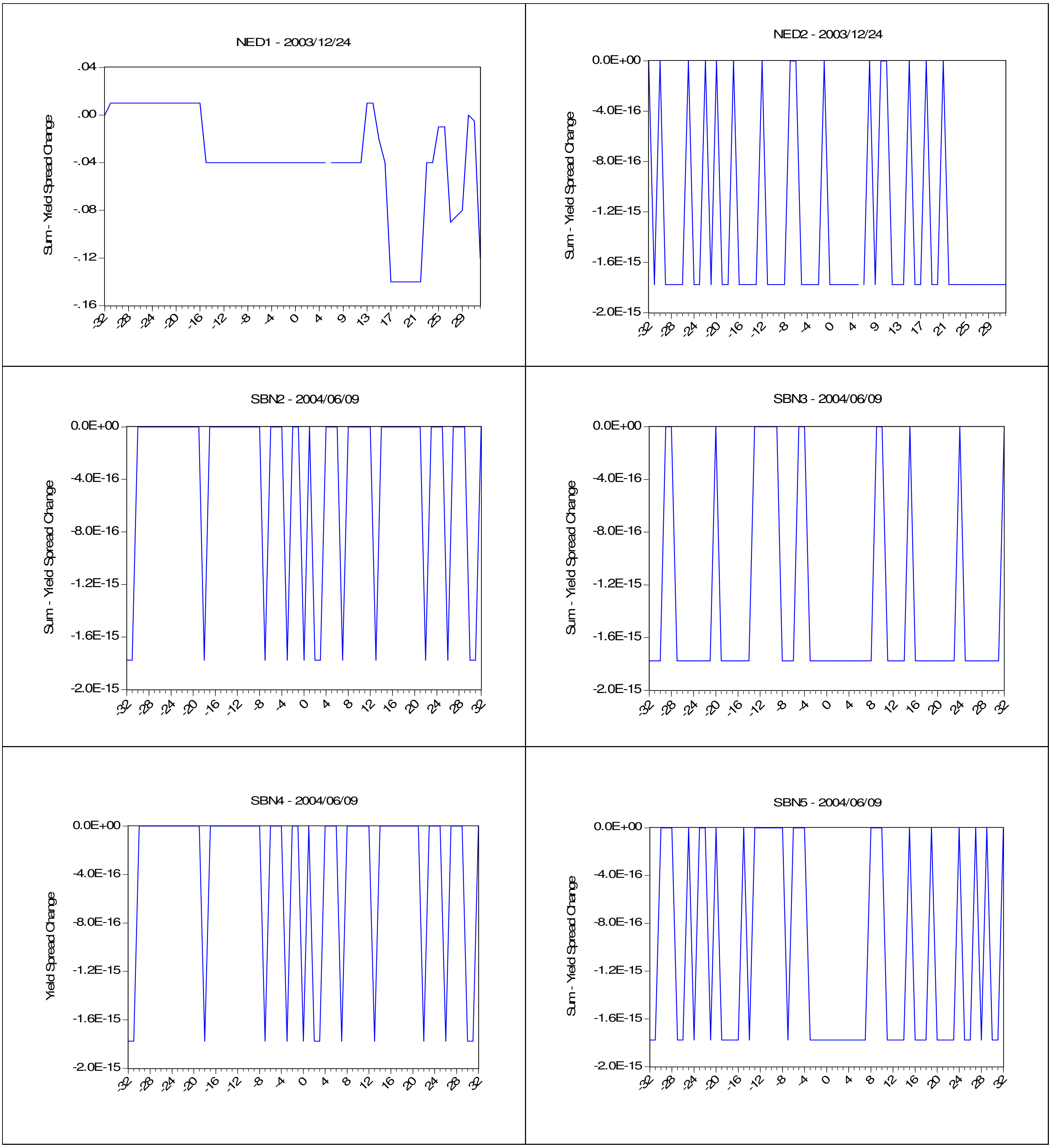
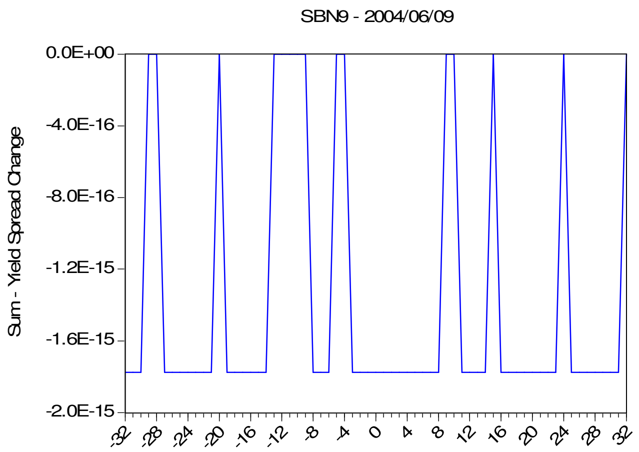
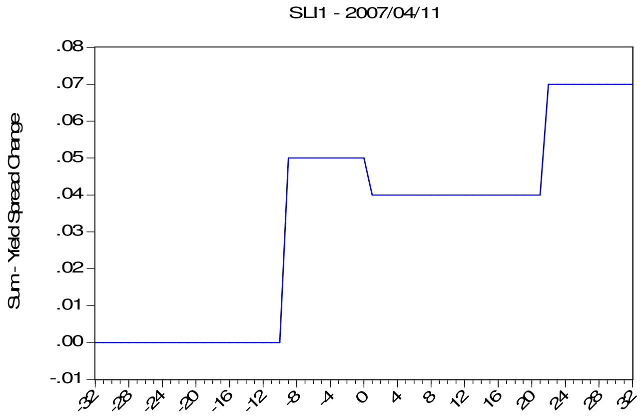
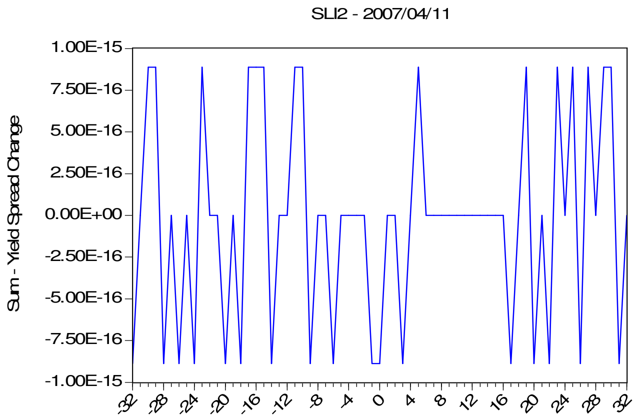
-4.0E-16
-8.0E-16
-1.2E-15
-1.6E-15
-2.0E-15
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32

Corporate Callable | Government – Summation of Yield Spread Change [-45; 45]



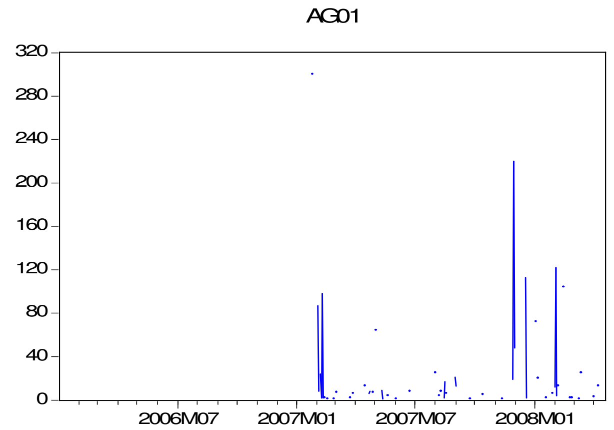

SBN9 - 2004/06/09
Sum - Yield Spread Change
0.0E+00
-4.0E-16
-8.0E-16
-1.2E-15
-1.6E-15
-2.0E-15
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32

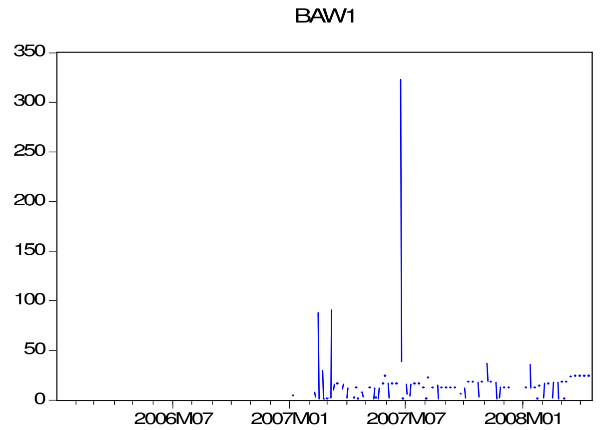

SLI1 - 2007/04/11
Sum - Yield Spread Change
.08
.07
.06
.05
.04
.03
.02
.01
.00
-.01
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32

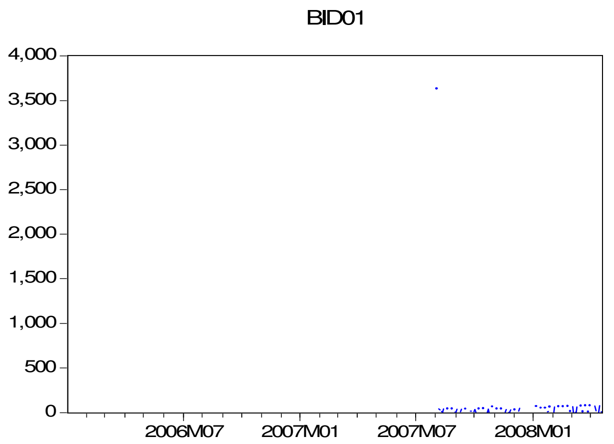

SLI2 - 2007/04/11
Sum - Yield Spread Change
1.00E-15
7.50E-16
5.00E-16
2.50E-16
0.00E+00
-2.50E-16
-5.00E-16
-7.50E-16
-1.00E-15
-32 -28 -24 -20 -16 -12 -8 -4 0 4 8 12 16 20 24 28 32

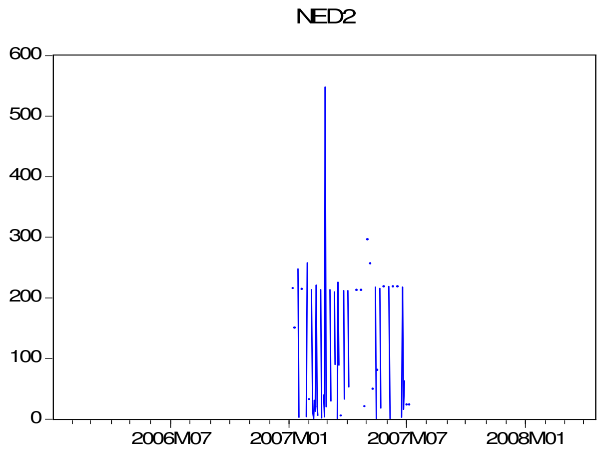
APPENDIX F

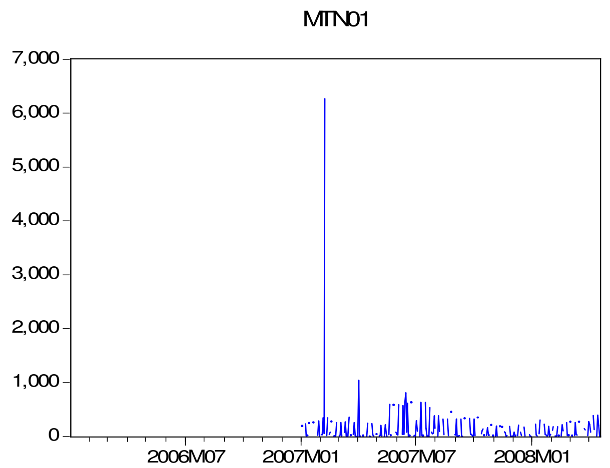
Volume Data: Corporate Bonds

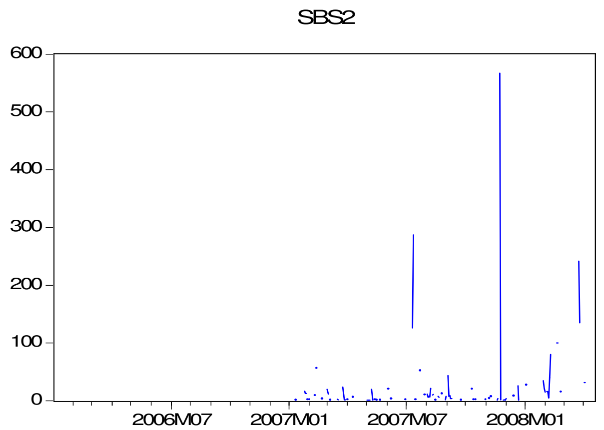


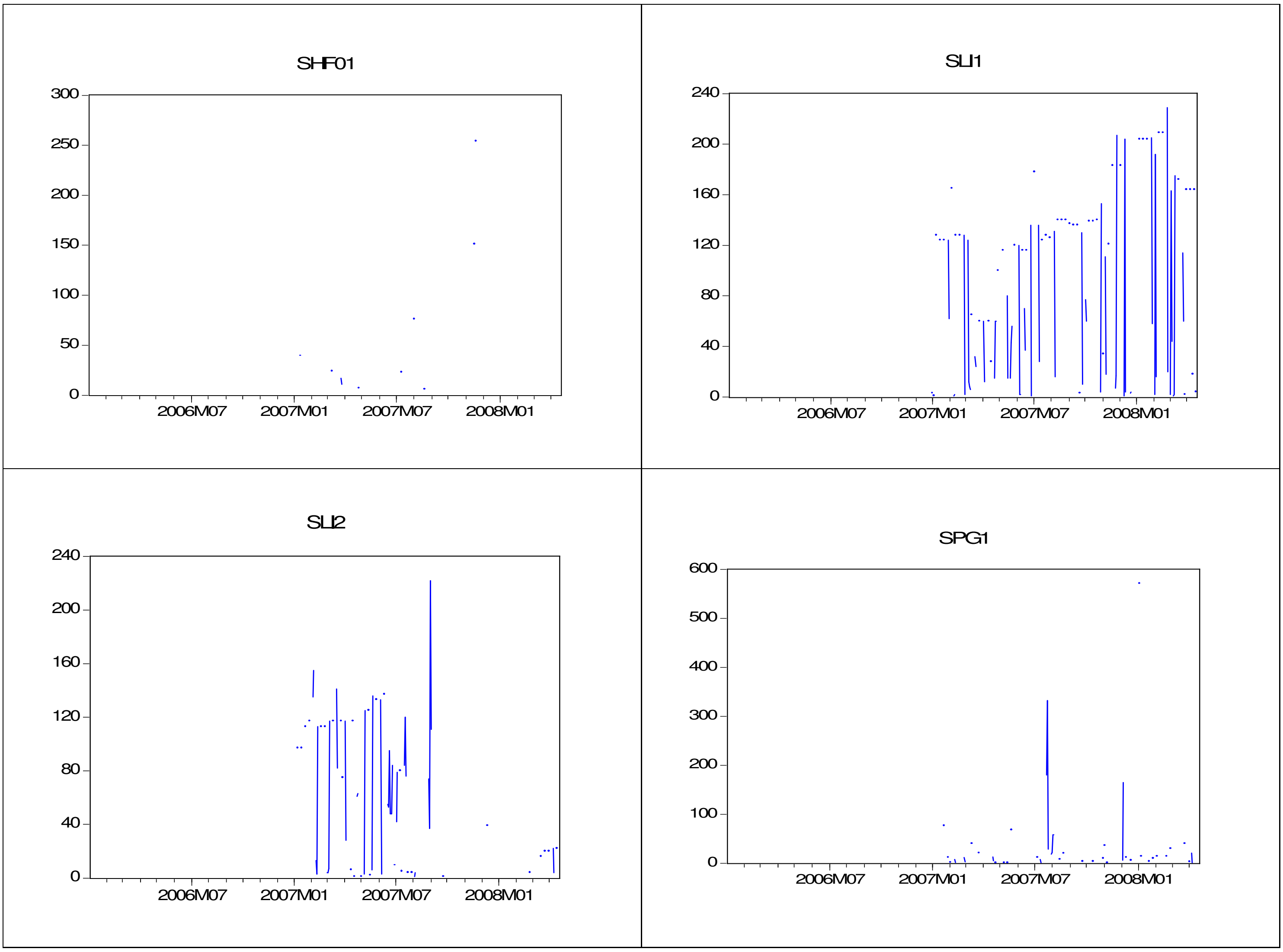




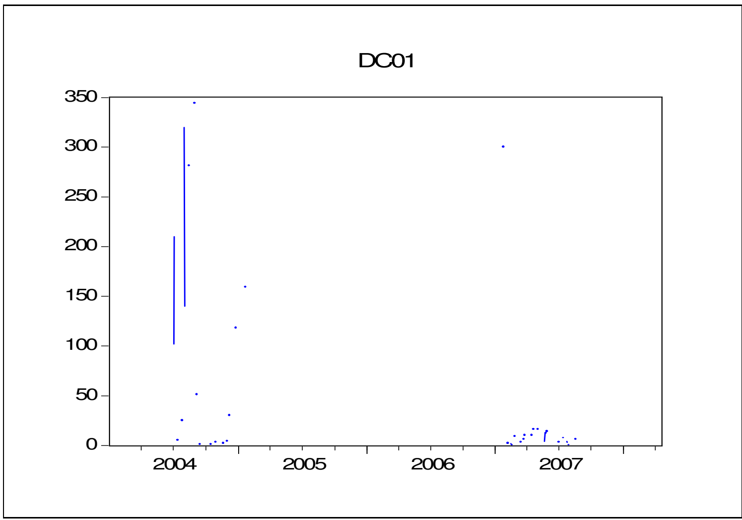


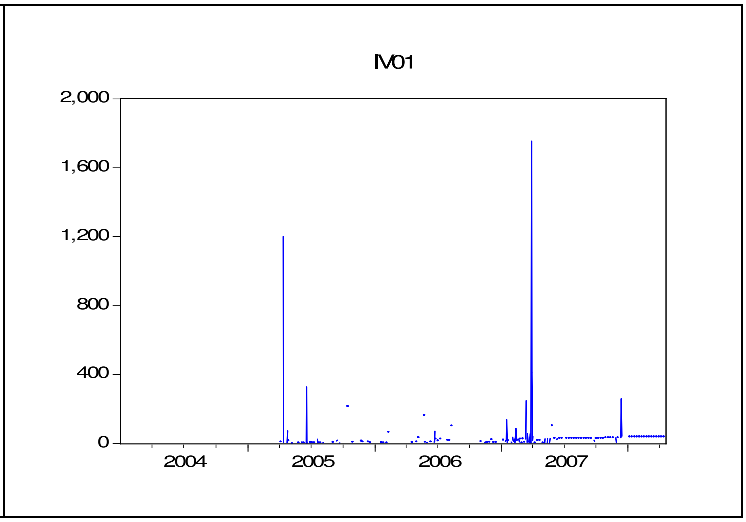




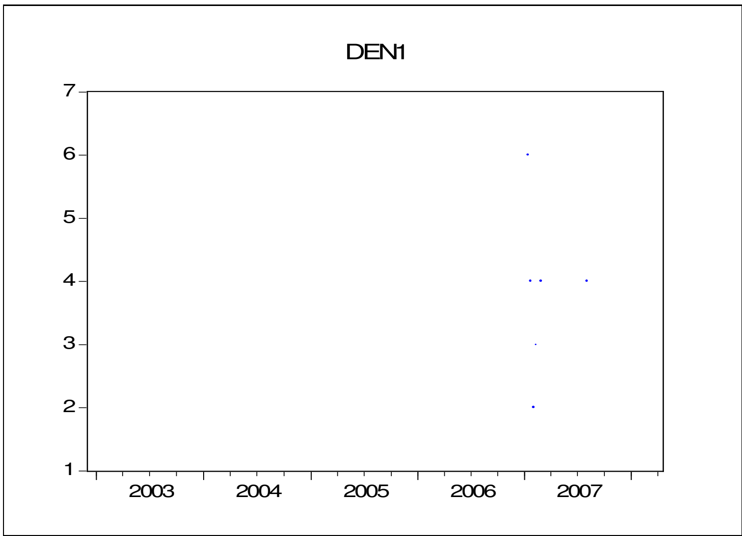

SHF01
300
250
200
150
100
50
0
2006M07
2007M01
2007M07
2008M01
SLI1
240
200
160
120
80
40
0
2006M07
2007M01
2007M07
2008M01
SLI2
240
200
160
120
80
40
0
2006M07
2007M01
2007M07
2008M01
SPG1
600
500
400
300
200
100
0
2006M07
2007M01
2007M07
2008M01

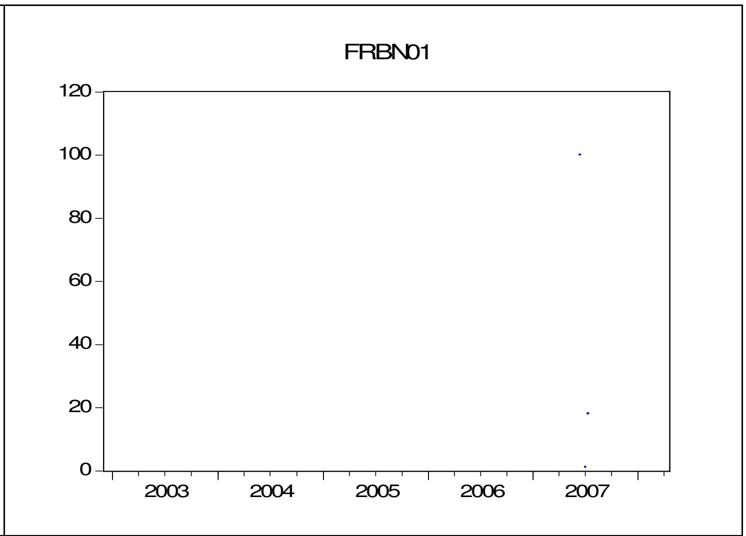
Semi-Liquid Corporate Bonds – Liquid pre-2006

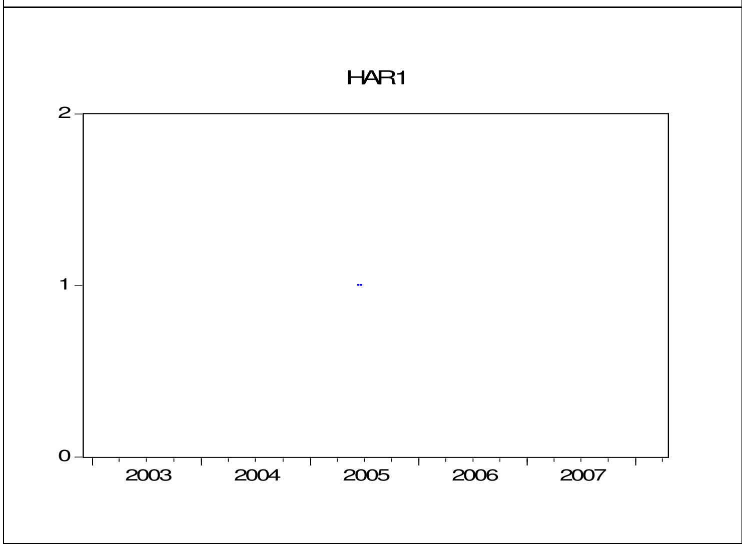




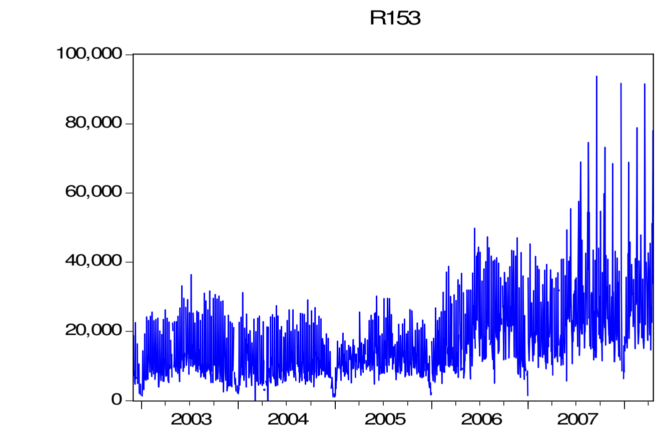
Illiquid Corporate Bonds

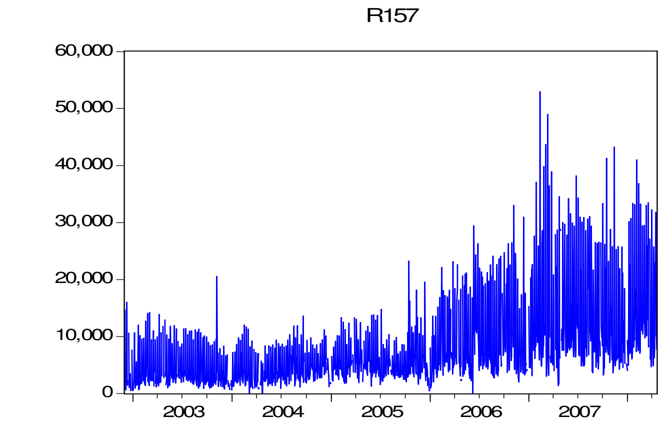


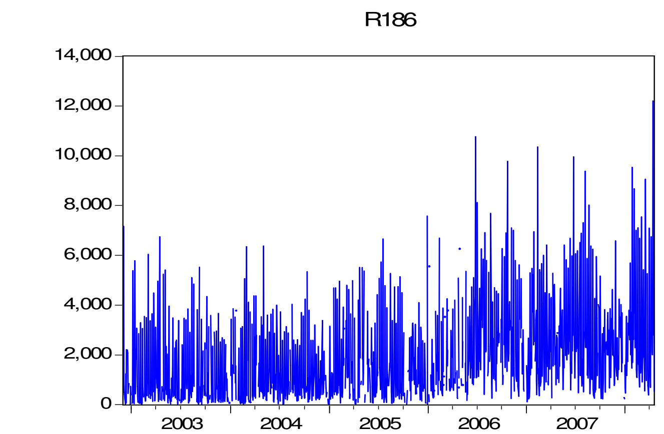


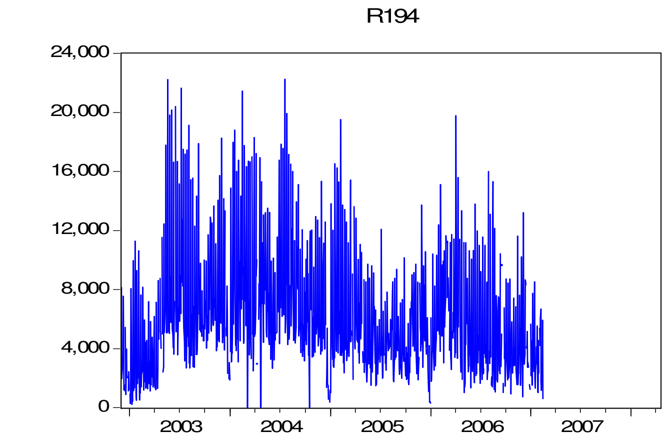


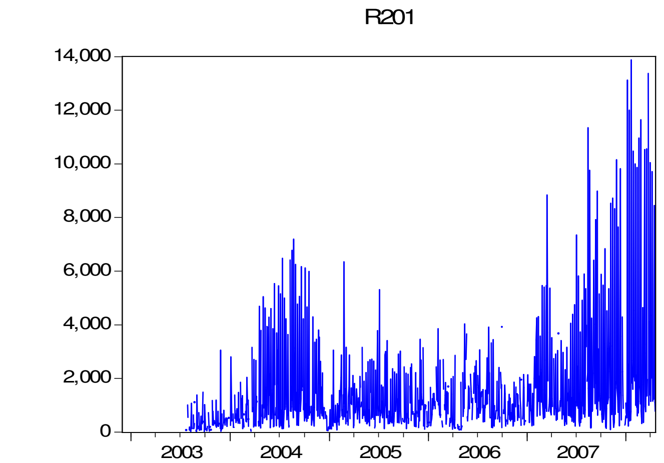
Volume Data: Government Bonds

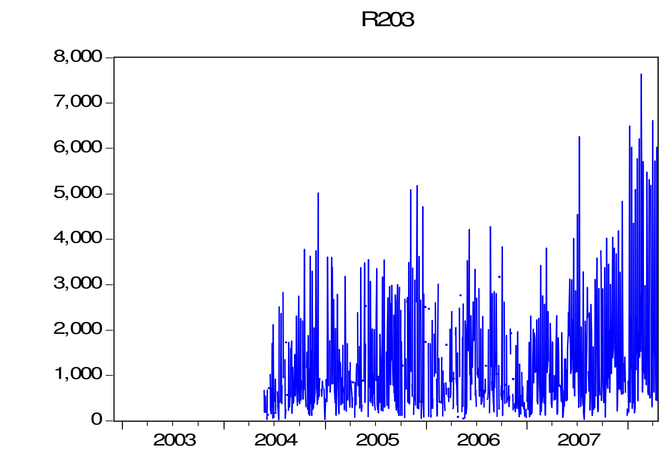


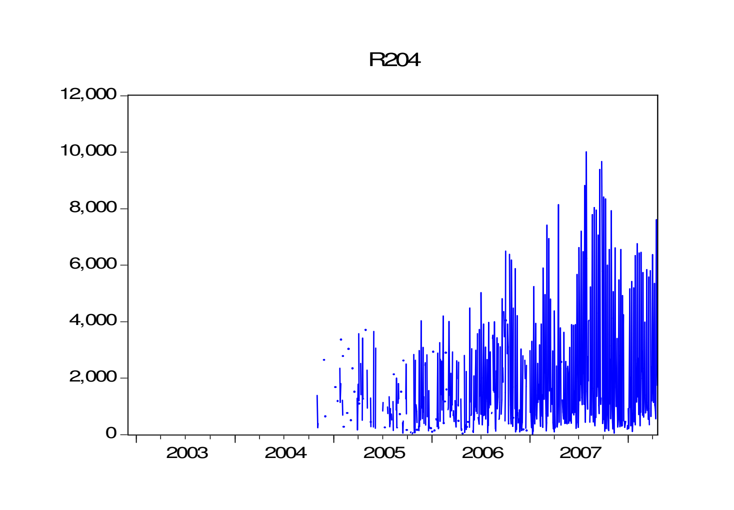


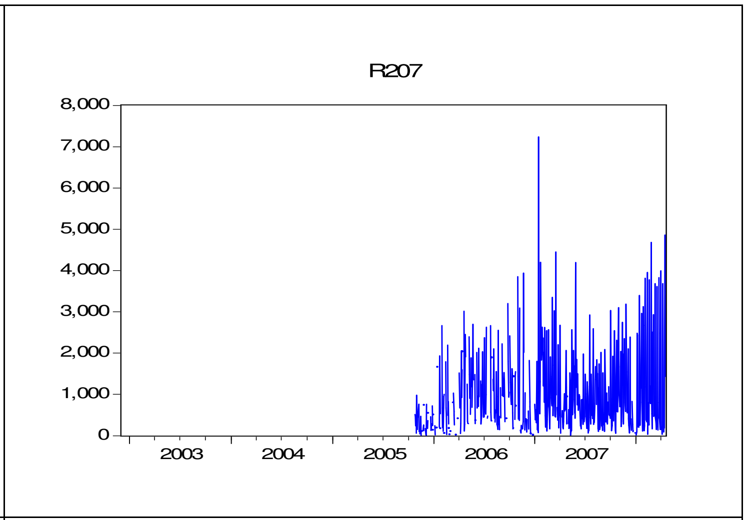


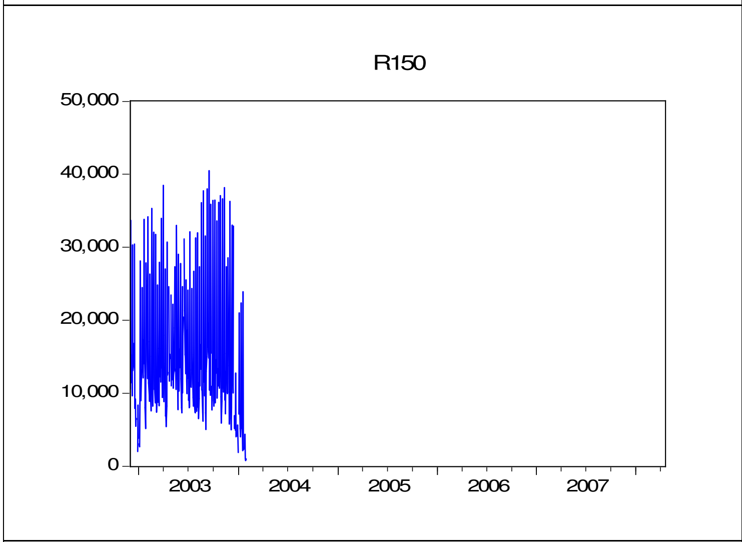


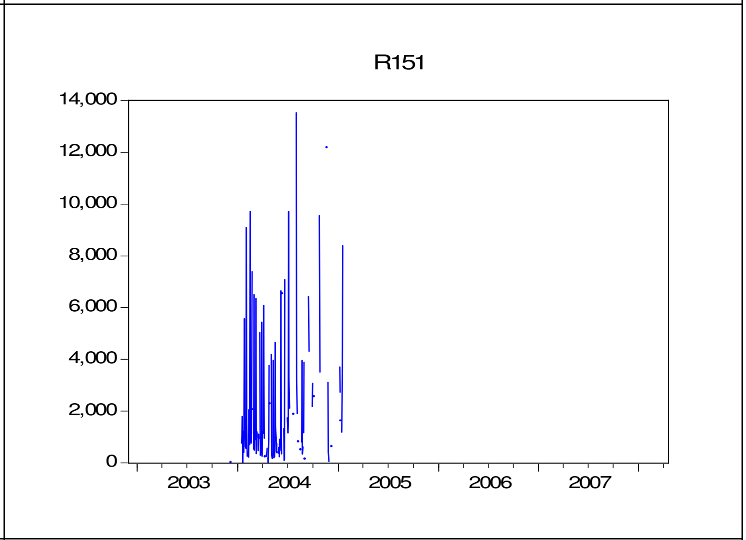


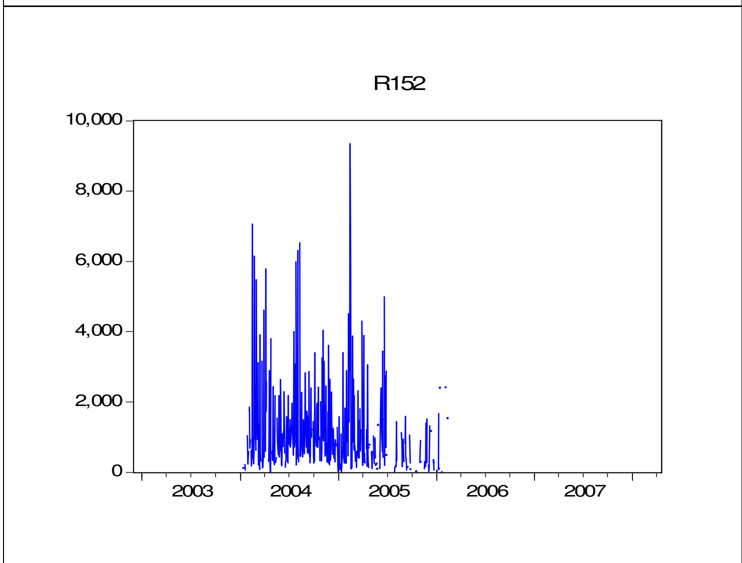


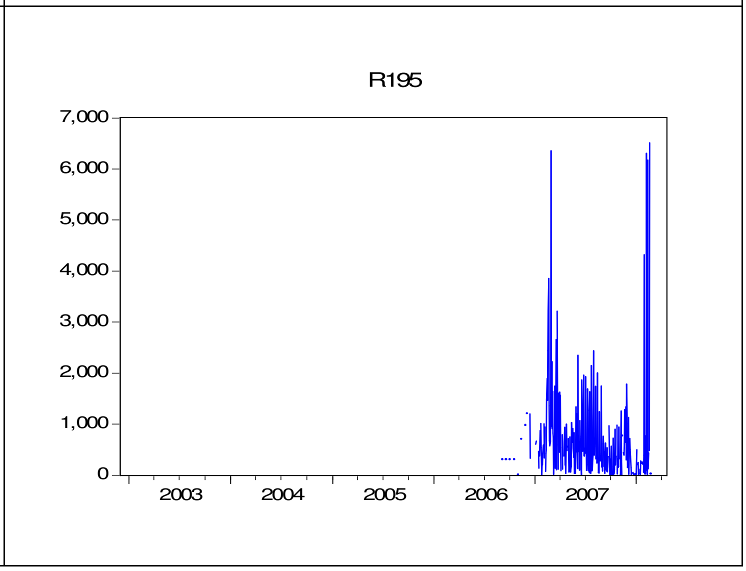

R204
12,000
10,000
8,000
6,000
4,000
2,000
0
2003
2004
2005
2006
2007

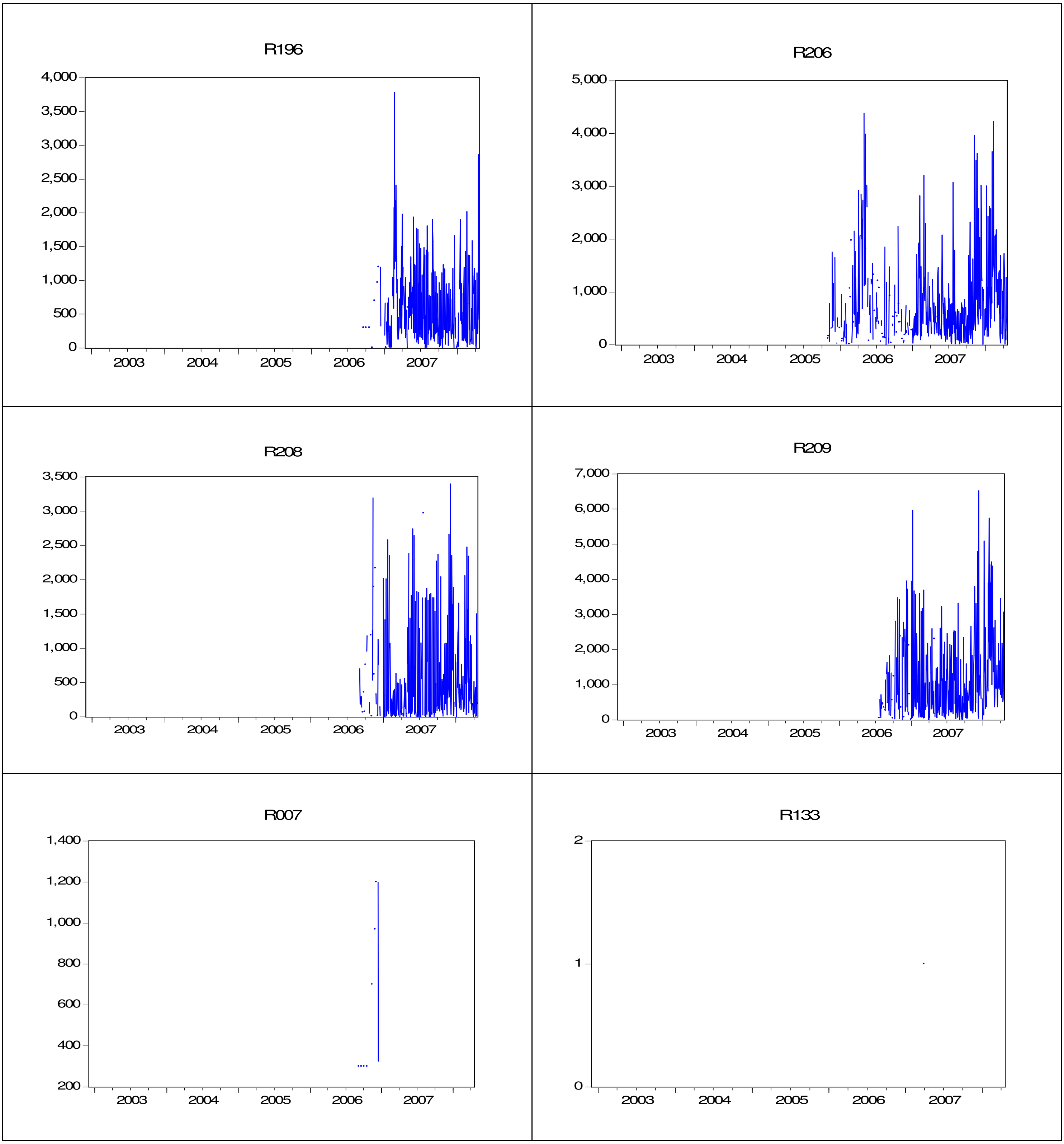

R207
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2003
2004
2005
2006
2007

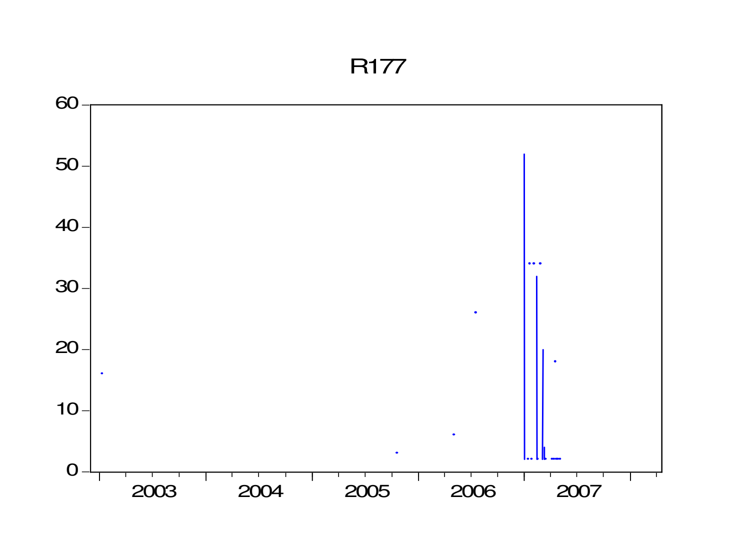

R150
50,000
40,000
30,000
20,000
10,000
0
2003
2004
2005
2006
2007

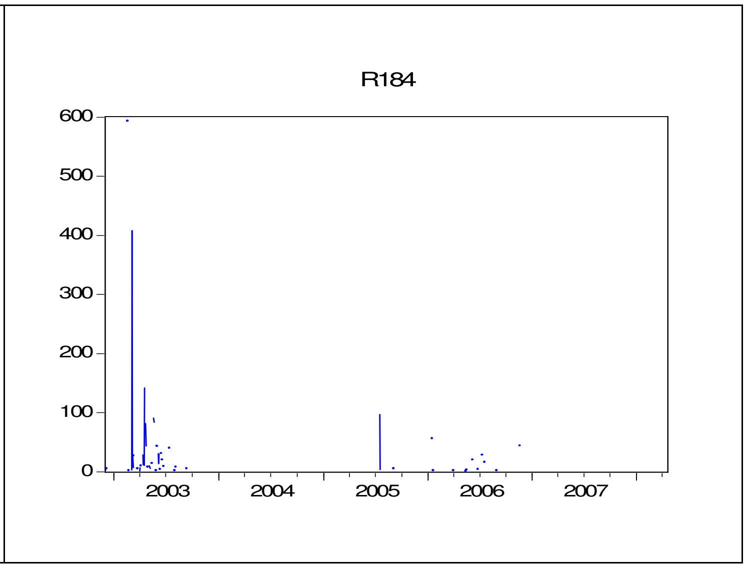

R151
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2003
2004
2005
2006
2007


R152
10,000
8,000
6,000
4,000
2,000
0
2003
2004
2005
2006
2007


R195
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2003
2004
2005
2006
2007


R196
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
2003
2004
2005
2006
2007
R206
5,000
4,000
3,000
2,000
1,000
0
2003
2004
2005
2006
2007
R208
3,500
3,000
2,500
2,000
1,500
1,000
500
0
2003
2004
2005
2006
2007
R209
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2003
2004
2005
2006
2007
R007
1,400
1,200
1,000
800
600
400
200
2003
2004
2005
2006
2007
R133
2
1
0
2003
2004
2005
2006
2007


R177
60
50
40
30
20
10
0
2003
2004
2005
2006
2007


R184
600
500
400
300
200
100
0
2003
2004
2005
2006
2007

APPENDIX H

Table 29. Government Bonds used in Spot-/ Forward Rate Calculation

Issue	ISIN #	Issue Date	Maturity Date	Issued Amount	Coupon
R 150	ZAG000010521	1989-05-02	2005-02-28	70,000,000,000	12%
R 151	ZAG000019332	2002-04-02	2005-02-28	26,171,520,264	12%
R 152	ZAG000019340	2002-04-02	2006-02-28	25,979,795,097	12%
R 153	ZAG000010539	1989-06-22	2010-08-31	98,708,390,655	13%
R 157	ZAG000010547	1991-01-18	2015-09-15	55,905,672,019	13.5%
R 186	ZAG000016320	1998-04-01	2026-12-21	39,024,788,732	10.5%
R 194	ZAG000017997	2001-04-01	2008-02-28	42,621,731,667	10%
R 195	ZAG000026691	2005-11-22	2008-02-28	23,123,016,270	10%
R 196	ZAG000026717	2005-11-22	2009-02-28	23,123,016,265	10%
R 201	ZAG000019878	2003-05-27	2014-12-21	36,488,954,842	8.75%
R 203	ZAG000021833	2004-05-07	2017-09-15	22,280,933,836	8.25%
R 204	ZAG000021841	2004-08-11	2018-12-21	23,499,000,000	8%
R 206	ZAG000024720	2005-08-11	2014-01-15	12,022,000,000	7.5%
R 207	ZAG000024738	2005-06-17	2020-01-15	14,858,000,000	7.25%
R 208	ZAG000030396	2006-09-01	2021-03-31	3,617,000,000	6.75%
R 209	ZAG000030404	2006-07-21	2036-03-31	7,998,000,000	6.25%
R006	ZAG000019324	2002-04-02	2004-02-28	50,000,000,000	12%
R007	ZAG000026709	2005-11-22	2007-02-28	23,123,016,265	10%
R008	ZAG000044116	2007-09-05	2009-08-31	12,339,809	13%
R089	ZAG000010281	1979-02-01	2025-12-21	473,100	9%
R093	ZAG000010299	1979-06-01	2025-12-21	1,235,750	9.2%5
R097	ZAG000010307	1979-07-02	2025-12-21	1,204,191	9.37%5
R 124	ZAG000010398	1984-04-16	2005-07-15	152,222,906	13%
R 126	ZAG000010406	1984-09-17	2006-10-15	77,788,113	14.5%
R 133	ZAG000010422	1986-02-18	2007-09-15	7,027,688	15%
R 154	ZAG000044124	2007-09-05	2010-08-31	12,339,809	13%
R 155	ZAG000044132	2007-09-05	2011-08-31	12,339,809	13%
R 177	ZAG000010661	1994-04-15	2007-05-15	89,153,627	9.5%
R 179	ZAG000010687	1994-04-21	2013-08-01	60,000,000	10%
R 184	ZAG000016114	1996-03-26	2006-12-21	1,906,531,147	12.5%

APPENDIX I

The value of a two-period bond written according to Equation Error! Reference source not found., as captured by Equation [14]:

$$
\begin{aligned}
V_{02} &= (aP_1 + CP_2 + CP_{no\_default})e^{-r_{01}^G}(aP_2 + CP_{no\_default} + P_{no\_default})e^{-r_{02}^G} \\
&= [aP_1 + CP_2 + C(1-P_1-P_2)]e^{-r_{01}^G} + [aP_2 + C(1-P_1-P_2) + (1-P_1-P_2)]e^{-r_{02}^G}
\end{aligned}
$$

The Difference in the calculated values of a two-period bond

V_{12} according to Elton et al (2001) – Equation [8]:

$$
\begin{aligned}
V_{12} &= [C(1-P_2) + aP_2 + (1-P_2)]e^{-r_{12}^G} \\
&= (C - CP_2 + aP_2 + 1 - P_2)e^{-r_{12}^G}
\end{aligned}
$$

Rewriting V_{12} as $(1-P_1)V_{12}$:

$$
\begin{aligned}
(1-P_1)V_{12} &= (1-P_1)[C(1-P_2) + aP_2 + (1-P_2)]e^{-r_{12}^G} \\
&= [(C - CP_2 + aP_2 + 1 - P_2)e^{-r_{12}^G}] + [(-CP_1 + CP_1P_2 - aP_1P_2 - P_1 + P_1P_2)e^{-r_{12}^G}]
\end{aligned}
$$

Subtract Equation [14] from Equation [10]:

$$
\begin{aligned}
\Delta V_{02} &= [aP_1 + CP_2 + C(1-P_1-P_2)]e^{-r_{01}^G} + [aP_2 + C(1-P_1-P_2) + (1-P_1-P_2)]e^{-r_{02}^G} \\
&\quad - [C(1-P_1) + aP_1 + (1-P_1)V_{12}]e^{-r_{01}^G}
\end{aligned}
$$

Rearrange the equation to isolate $(1-P_1)V_{12}$:

$$
\begin{aligned}
\Delta V_{02} &= [aP_1 + CP_2 + C(1-P_1-P_2)]e^{-r_{01}^G} + [aP_2 + C(1-P_1-P_2) + (1-P_1-P_2)]e^{-r_{02}^G} \\
&\quad + [-C + CP_1 - aP_1]e^{-r_{01}^G} - [(1-P_1)V_{12}]e^{-r_{01}^G}
\end{aligned}
$$

Substitute $(1-P_1)V_{12}$:

$$\begin{aligned}\Delta V_{02} = &[aP_1 + CP_2 + C - CP_1 - CP_2)]e^{-r_{01}^G} \\ &+ [aP_2 + C - CP_1 - CP_2)]e^{-r_{02}^G} \\ &+ [1 - P_1 - P_2]e^{-r_{02}^G} \\ &+ [-C + CP_1 - aP_1]e^{-r_{01}^G} \\ &+ [(-C + CP_2 - aP_2 - 1 + P_2)e^{-r_{12}^G}]e^{-r_{01}^G} \\ &+ [(CP_1 - CP_1P_2 + aP_1P_2 + P_1 - P_1P_2)e^{-r_{12}^G}]e^{-r_{01}^G}\end{aligned}$$

$$\begin{aligned}\Delta V_{02} = &[aP_1e^{-r_{01}^G} + CP_2e^{-r_{01}^G} + Ce^{-r_{01}^G} - CP_1e^{-r_{01}^G} - CP_2e^{-r_{01}^G}] \\ &+ [aP_2e^{-r_{02}^G} + Ce^{-r_{02}^G} - CP_1e^{-r_{02}^G} - CP_2e^{-r_{02}^G}] \\ &+ [e^{-r_{02}^G} - P_1e^{-r_{02}^G} - P_2e^{-r_{02}^G}] \\ &+ [-Ce^{-r_{01}^G} + CP_1e^{-r_{01}^G} - aP_1e^{-r_{01}^G}] \\ &+ [-Ce^{-r_{02}^G} + CP_2e^{-r_{02}^G} - aP_2e^{-r_{02}^G} - e^{-r_{02}^G} + P_2e^{-r_{02}^G}] \\ &+ [CP_1e^{-r_{02}^G} - CP_1P_2e^{-r_{02}^G} + aP_1P_2e^{-r_{02}^G} + P_1e^{-r_{02}^G} - P_1P_2e^{-r_{02}^G}]\end{aligned}$$

$$\Delta V_{02} = -P_1P_2(C + 1 - a)e^{-r_{02}^G}$$

The resultant difference in the Spot Rate Spread

Set Equation [11] equal to Equation [14], instead of Equation [10]:

$$(C + V_{12})e^{-r_{01}^C} = [aP_1 + CP_2 + C(1 - P_1 - P_2)]e^{-r_{01}^G} + [aP_2 + C(1 - P_1 - P_2) + (1 - P_1 - P_2)]e^{-r_{02}^G}$$

$$(C + V_{12})e^{-r_{01}^C} = [aP_1 + CP_2 + C - CP_1 - CP_2 + (aP_2 + C - CP_1 - CP_2 + 1 - P_1 - P_2)e^{-r_{12}^G}]e^{-r_{01}^G}$$

Rearrange the terms to solve $e^{-(r_{01}^C - r_{01}^G)}$

$$e^{-(r_{01}^C - r_{01}^G)} = \frac{[aP_1 + CP_2 + C - CP_1 - CP_2 + (aP_2 + C - CP_1 - CP_2 + 1 - P_1 - P_2)e^{-r_{12}^G}]}{(C + V_{12})}$$

$$e^{-(r_{01}^C - r_{01}^G)} = \frac{[aP_1 + CP_2 + C - CP_1 - CP_2 - (CP_1 + P_1)e^{-r_{12}^G} + (C - CP_2 + aP_2 + 1 - P_2)e^{-r_{12}^G}]}{(C + V_{12})}$$

$$= \frac{[aP_1 + C - CP_1 - (CP_1 + P_1)e^{-r_{12}^G} + (C - CP_2 + aP_2 + 1 - P_2)e^{-r_{12}^G}]}{(C + V_{12})}$$

$$= \frac{aP_1}{(C + V_{12})} + \frac{C(1 - P_1)}{(C + V_{12})} - \frac{P_1(C+1)e^{-r_{12}^G}}{(C + V_{12})} + \frac{[(C - CP_2 + aP_2 + 1 - P_2)e^{-r_{12}^G}]}{(C + V_{12})}$$

Subtract Equation [13] from the answer:

$$\Delta e^{-(r_{01}^C - r_{01}^G)} = \frac{aP_1}{(C + V_{12})} + \frac{C(1 - P_1)}{(C + V_{12})} - \frac{P_1(C+1)e^{-r_{12}^G}}{(C + V_{12})} + \frac{[(C - CP_2 + aP_2 + 1 - P_2)e^{-r_{12}^G}]}{(C + V_{12})} - \frac{aP_1}{(C + V_{12})} - \frac{(1 - P_1)(C + V_{12})}{(C + V_{12})}$$

$$\Delta e^{-(r_{01}^C - r_{01}^G)} = \frac{aP_1}{(C + V_{12})} + \frac{C(1 - P_1)}{(C + V_{12})} - \frac{P_1(C+1)e^{-r_{12}^G}}{(C + V_{12})} + \frac{V_{12}}{(C + V_{12})} - \frac{aP_1}{(C + V_{12})} - \frac{C(1 - P_1)}{(C + V_{12})} - \frac{(1 - P_1)V_{12}}{(C + V_{12})}$$

$$= \frac{-P_1(C+1)e^{-r_{12}^G} + P_1V_{12}}{(C + V_{12})}$$

$$= \frac{P_1V_{12}}{(C + V_{12})} - [\frac{P_1(C+1)}{(C + V_{12})}]e^{-r_{12}^G}$$

APPENDIX J

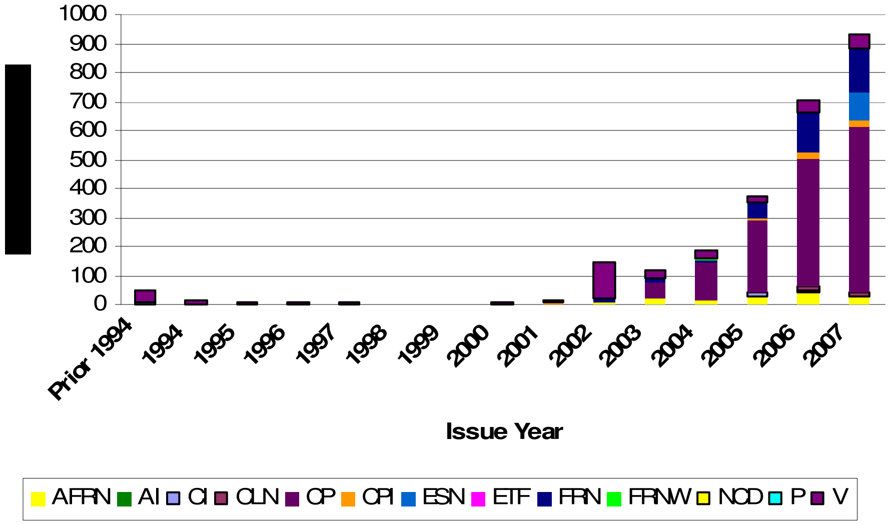


Figure 19. Number of Listed Bond Issues based on issue date

Source: BESA (2007)

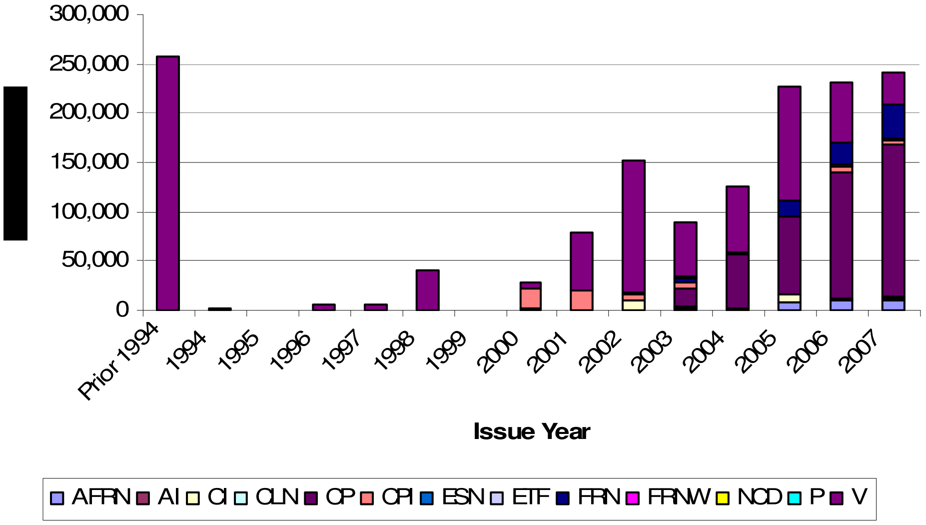


Figure 20. Value of Listed Bond Issues based on issue date

Source: BESA (2007)

Table 30. Number of Listed Bond Issues based on issue date

Type	Prior 1994	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total (Qty)
Amortising Floating Rate Notes	0	0	0	0	0	0	0	0	2	5	18	12	26	39	27	129
Amortising Instruments	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2
Customised Instruments	0	0	0	0	0	0	0	1	0	1	1	1	16	11	4	35
Credit Linked Note	0	0	0	0	0	0	0	0	0	0	2	1	1	11	7	22
Commercial Paper	1	0	0	0	0	0	0	0	0	2	51	128	247	441	577	1447
CPI-linked	0	0	0	0	0	0	0	1	2	1	1	1	8	22	20	56
Equity Structured Note	0	0	0	0	0	0	0	0	0	0	0	0	0	3	94	97
Exchange Traded Fund	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Floating Rate Note	0	0	0	0	0	0	0	0	0	10	13	8	53	134	150	368
Weighted Floating Rate Note	0	0	0	0	0	0	0	0	0	0	3	8	0	0	0	11
Negotiable Certificate of Deposit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perpetuity	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Vanilla	47	13	5	4	6	2	1	7	9	123	25	28	23	42	53	388
Total	51	13	5	4	6	2	1	9	13	142	115	188	374	703	934	2560

Source: BESA (2007)

Table 31. Value of Listed Bond Issues based on issue date

Type	Prior to 1994	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total (SAR million)
Amortising Floating Rate Notes	0	0	0	0	0	0	0	0	467	374	3,011	2,247	8,926	9,965	11,110	36,100
Amortising Instruments	0	0	0	0	0	0	0	0	0	0	575	287	0	0	0	861
Customised Instruments	0	0	0	0	0	0	0	2,500	0	8,800	195	107	6,361	1,763	913	20,639
Credit Linked Note	0	0	0	0	0	0	0	0	0	0	257	121	100	1,106	1,862	3,446
Commercial Paper	7	0	0	0	0	0	0	0	0	159	18,642	53,077	79,535	128,009	154,199	433,628
CPI-linked	0	0	0	0	0	0	0	19,848	19,418	5,995	6,465	562	1,195	5,337	3,559	62,379
Equity Structured Note	0	0	0	0	0	0	0	0	0	0	0	0	0	821	3,129	3,950
Exchange Traded Fund	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500	500
Floating Rate Note	0	0	0	0	0	0	0	0	0	3,890	4,141	2,405	15,647	23,466	33,960	83,509
Weighted Floating Rate Note	0	0	0	0	0	0	0	0	0	0	670	800	0	0	0	1,470
Negotiable Certificate of Deposit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perpetuity	26	0	0	0	0	0	0	0	0	0	0	0	0	0	1	27
Vanilla	256,783	1,921	630	7,070	6,616	41,324	500	6,970	58,814	132,092	54,644	66,898	115,178	59,630	32,262	841,333
Total	256,817	1,921	630	7,070	6,616	41,324	500	29,318	78,698	151,310	88,599	126,504	226,942	230,098	241,495	1,487,843

Source: BESA (2007)

Table 32. Issue Coverage - amount of ratings per issue type

Listed Bond Types	Issues	Rated	Fitch	Moody	CA	S&P
Amortising Floating Rate Notes	129	117	52	104	2	0
Amortising Instruments	2	2	0	2	0	0
Customised Instruments	35	27	11	7	14	0
Credit Linked Note	22	4	4	0	0	0
Commercial Paper	1447	1339	730	735	83	21
CPI-linked	56	39	39	12	1	0
Equity Structured Note	97	1	0	0	0	1
Exchange Traded Fund	1	0	0	0	0	0
Floating Rate Note	368	265	139	145	13	4
Weighted Floating Rate Note	11	11	3	8	0	0
Negotiable Certificate of Deposit	0	0	0	0	0	0
Perpetuity	4	0	0	0	0	0
Vanilla	388	191	155	61	27	10
Total	2560	1996	1133	1074	140	36

Source: BESA (2007)

Table 33. Issue Maturity per issue type

Maturity (years)	AFRN	AI	CI	CLN	CP	CPI	ESN	ETF	FRN	FRNW	NCD	P	V	Total
0 <> 1	8	0	19	10	1443	1	96	0	66	0	0	0	4	1647
1 <> 2	7	0	2	0	1	1	0	0	33	0	0	0	10	54
2 <> 5	67	0	4	2	2	18	0	0	178	4	0	1	90	366
5 <> 12	47	2	7	5	0	20	1	0	80	7	0	0	147	316
12 <	0	0	3	5	1	16	0	1	11	0	0	3	137	177
Total	129	2	35	22	1447	56	97	1	368	11	0	4	388	2560

Source: BESA (2007)

Table 34. Rating Distributions per issue type

	Agency	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	Total	A1+	A1	A2	A3	B	C	Total	Agency	
AFRN	F	25	0	5	2	1	5	2	1	7	0	0	1	0	0	0	0	49	3	0	0	0	0	0	3	F	AFRN
	M	52	2	7	0	4	10	1	0	8	2	2	6	0	0	1	0	95	5	0	0	0	0	0	5	M	
	CA	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	77	2	12	3	5	15	4	1	15	2	2	7	0	0	1	0	146	8	1	0	0	0	0	9	Total	
AI	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	F	AI
	M	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	M	
	CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	Total	
CI	F	6	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	1	0	0	0	0	1	F	CI
	M	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	M	
	CA	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	12	3	1	0	0	0	1	0	14	0	0	0	0	0	0	0	31	0	1	0	0	0	0	1	Total	
CLN	F	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0	4	F	CLN
	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	
	CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0	4	Total	
CP	F	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4	724	2	0	0	0	0	726	F	CP
	M	6	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	21	701	0	0	0	0	0	701	M	
	CA	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	80	0	0	0	0	80	CA	
	SP	0	1	0	0	20	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	SP	
	Total	7	3	3	0	35	0	0	0	0	0	0	0	0	0	0	0	48	1425	82	0	0	0	0	1507	Total	
CPI	F	11	18	0	10	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	F	CPI
	M	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	M	
	CA	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	12	18	12	10	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	0	0	0	0	0	Total	
ESN	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	F	ESN
	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	
	CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CA	
	SP	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	SP	
	Total	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	Total	

	Agency	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	Total	A1+	A1	A2	A3	B	C	Total	Agency	
ETF	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	F	ETF
	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	
	CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Total	
FRN	F	52	9	19	13	1	13	5	0	18	1	0	3	0	0	0	0	134	5	2	0	0	0	0	7	F	FRN
	M	90	4	13	4	4	7	9	2	3	3	0	1	1	0	0	0	141	4	0	0	0	0	0	4	M	
	CA	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	CA	
	SP	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	SP	
	Total	145	13	32	17	5	20	14	3	34	4	0	4	1	0	0	0	292	9	2	0	0	0	0	11	Total	
FRNW	F	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	F	FRNW
	M	2	0	2	0	0	2	0	0	2	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	M	
	CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	3	0	2	0	0	3	0	0	3	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	Total	
NCD	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	F	NCD
	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	
	CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Total	
P	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	F	P
	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	
	CA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CA	
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SP	
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Total	
V	F	57	44	12	18	9	10	1	2	1	1	0	0	0	0	0	0	155	25	0	0	0	0	0	25	F	V
	M	15	1	13	15	3	5	2	1	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	M	
	CA	4	5	3	0	6	5	2	0	1	0	0	0	0	0	0	0	26	1	2	0	0	0	0	3	CA	
	SP	3	0	1	0	1	0	0	3	0	0	2	0	0	0	0	0	10	0	0	0	0	0	0	0	SP	
	Total	79	50	29	33	19	20	5	6	2	1	2	0	0	0	0	0	246	26	2	0	0	0	0	28	Total	
		337	93	91	63	64	58	24	10	68	7	4	11	1	0	1	0	832	1472	88	0	0	0	0	1560		

Source: BESA (2007)

Table 35. Rating Coverage - number of Agencies covering an issue

Ratings per issue	AFRN	AI	CI	CLN	CP	CPI	ESN	ETF	FRN	FRNW	NCD	P	V	Total
0	12	0	8	18	108	17	96	1	103	0	0	4	197	**564**
1	77	2	22	4	1110	26	1	0	232	11	0	0	137	**1622**
2	39	0	5	0	229	13	0	0	30	0	0	0	47	**363**
3	1	0	0	0	0	0	0	0	3	0	0	0	6	**10**
4	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
Total	129	2	35	22	1447	56	97	1	368	11	0	4	388	

Source: BESA (2007)