How much credit should be given to credit spreads?

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This paper sets out to assess the information that can be derived from spreads between yields on government bonds, considered as having a zero default probability, and yields on risky bonds, i.e. *whose default probability is not zero. In the first part, we shall give a reminder of the main theoretical approaches used for calculating default risk and its term structure, and, in the second part, we shall examine the difficulties encountered in the empirical analysis of credit spreads. We shall also focus on the problems involved in measuring spreads and the limitations of their information content, given that they may reflect, above and beyond the default risk, the existence of a liquidity risk.*

Credit spreads, *i.e.* the spread between the yield on a corporate bond and the yield on a government bond [1], have long been a focus of attention. In the past few years there has been renewed interest in studying these spreads due to the decline in government debt issuance associated with the reduction in fiscal deficits at the end of the 1990s, and the attendant sharp increase in debt securities issued by private borrowers, as well as the recent expansion of the credit derivatives market. These spreads have been studied in terms of the issuer's rating and sector, the bond's maturity, duration, etc. Given the increasing influence of the rating awarded by international credit rating agencies — in prudential regulation with the Basel II accords, and in the asset management industry with the quantitative constraints on lower-rated issuers — it is important to consider the link between the rating, which is a qualitative measurement of default risk, and the yield spread, which is a quantitative measurement: how reliable are ratings as an indicator of the level of credit risk? When analysing credit risk, we are faced with a number of technical problems associated with the actual measurement of these spreads, and the fact that they also reflect premiums, some of which have no direct link with default risk, such as the liquidity premium. For example, flights to quality are also flights to liquidity, and the widening of spreads during financial crises indicates both an increase in default risk and the liquidity risk. The fundamental question is therefore to ascertain whether it is possible to measure, in the yield spreads observed on the market, the component actually reflecting default risk, *i.e.* the probability of an issuer defaulting and the recovery rate (percentage of the debt recovered in the event of a default), which would allow these spreads to be used more effectively as credit risk indicators.

[1] *These spreads may also be measured against the swap yield curve, hence the term "swap spreads".*

1| Credit risk in financial theory

Two main theoretical approaches are used for measuring credit risk:

- The "structural" approach, which posits that the asset value of a firm follows a stochastic process, and that the price of the firm's debt is equal to that of a put option on this value;

- and the "reduced-form" approach, in which the default is given exogenously and the default and recovery rates are randomly modelled for a homogenous (in terms of credit risk) sample of issuers generally grouped by rating.

It is however necessary, in both cases, to have information on the recovery rate in the event of default, which is an important factor of credit risk. In addition to the recovery rate, the maturity of bonds is another explanatory variable of spreads, even though the results of studies differ with regard to the shape of the term structure of yield spreads for speculative grade issuers (*i.e.* rated below BBB by Standard and Poor's and Baa by Moody's).

1|1 The "structural" approach: estimating the asset value of a firm

This approach was first set out in articles by Black and Scholes (1973) and Merton (1974). It consists in modelling variations in the asset value of a firm. A firm defaults on its debt if the value of its assets falls below a specific threshold, in other words, the default is linked to specific characteristics of the firm.

The logic is the following.

V denotes the value of the firm. Its assets are financed by issuing equity E and zero-coupon bonds (so as to avoid having to take into account intermediary interest rate flows) with maturity T, face value F and market value D. A credit risk appears when, at maturity, the asset value of a firm is likely to fall below the face value of this debt.

At maturity, what is the risk profile of the bondholder?

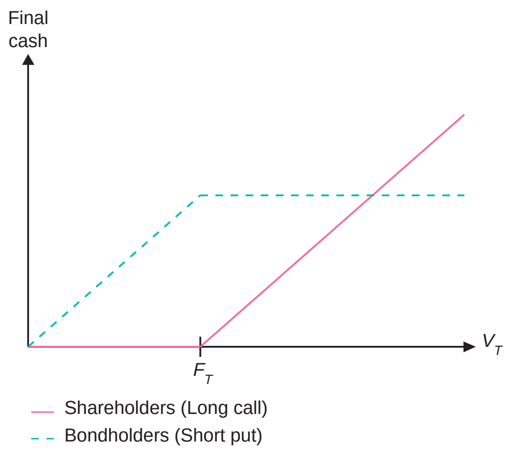
If the value of the firm is greater than the face value of the debt, the investor recovers this face value, which is the maximum amount that can be obtained. However, if the value of the firm is lower than the face value of the debt, despite the fact that bondholders have priority over shareholders, the bondholder only recovers the residual value of the firm, which may even be zero, *i.e.* a recovery rate of zero.

By using the analytical framework of options and their risk profile at expiry, the position of the bondholder is therefore similar to that of the writer of a put option on the assets of the firm with a strike price equal to the face value of the debt.

The market value of the bond at maturity is thus equal to either the face value of this bond (if $V_T > F_T$), or the residual value of the firm (if $V_T < F_T$).

For the shareholder, the situation is the opposite: if the firm defaults, the equity investor recovers nothing. However, if the value of the firm exceeds the face value of the debt ($V_T > F_T$), the shareholder's wealth increases in line with the value of the firm's assets. We can therefore say that the shareholder's position is equivalent to that of the buyer of a call option on the value of the firm's assets with a strike price equal to the nominal value of the debt.

Risk profile at maturity of the debt



Under a number of assumptions regarding the pattern of the asset value of a firm, an option-pricing approach can be used to calculate the value of the debt [2]. The price of a risky bond is equal to that of a risk-free bond (government bond) with an identical maturity, minus the value of a put option with strike price *F* (as the holder of a corporate bond has an equivalent position to the writer of a put option). Logically, the price of a risky bond will be lower than that of a risk-free bond, given that the yield on the risky bond is higher than that on the risk-free bond. This difference in yield corresponds to the credit spread, which can then be computed directly.

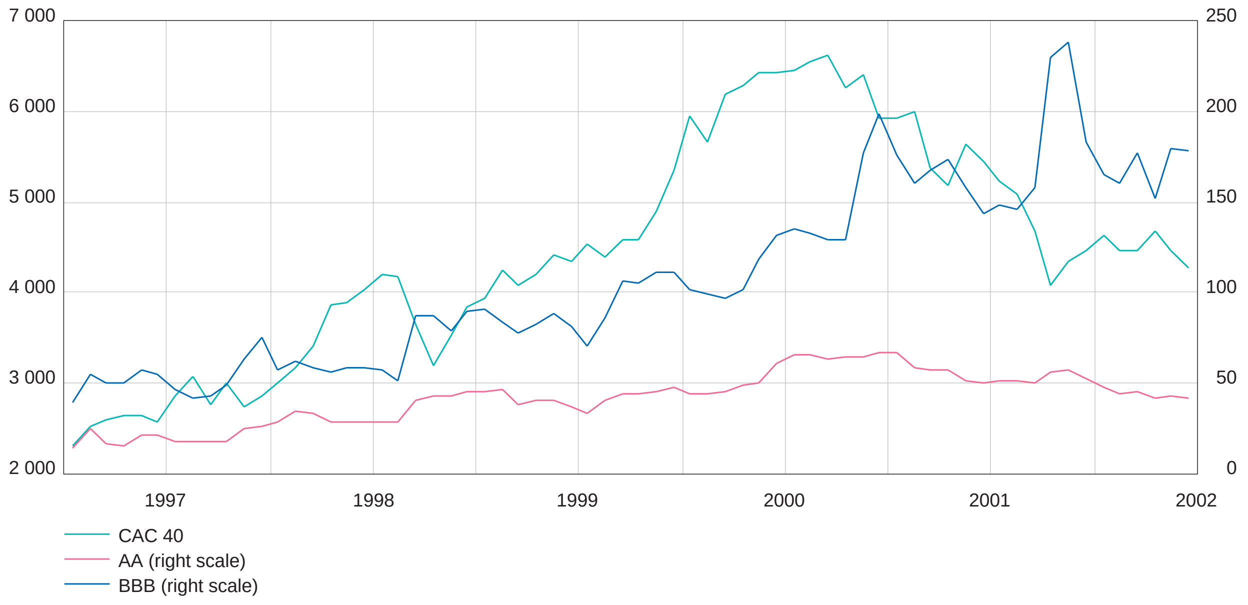
The implications of the model: the link between the stock market and the credit spread

In Merton's model, the market value of the risky bond, or the value of the spread, depends on two fundamental factors:

– *Leverage or, more specifically, the ratio between the present value (the price) of the debt and the firm's capital (equity).* An increase in the price of the firm's equity — except in the case of a speculative bubble — or a capital increase (issuing shares), results in, *ceteris paribus*, a reduction in leverage and hence a decline in default risk, leading to a narrowing of the spread. Conversely, a drop in the share price, or a company share buyback, results in an increase in leverage and hence an increase in default risk, leading in turn to a widening of the spread. The above assumes that changes in the value of the firm measured by changes in its share price actually reflect changes in its fundamental value. If this were not the case, this linkage between share prices and default risk reflected by the credit spread would cease to be relevant. Therefore, in the case of a speculative bubble, for example, the narrowing of spreads should not be interpreted as a sign of structural decline in the companies' default risk, but rather as a sign of a lesser perception of risks in the context of collective euphoria. The chart below shows a continuous rise in the spreads, while the price of shares initially rises and then falls. The explanation is straightforward: over the period, the leverage effect increases regularly, firstly due to growing corporate debt (increase in the numerator, *i.e.* the debt), and secondly to the fall in stock prices (decrease in the denominator, *i.e.* the value of the equity).

Comparison of trends in the CAC 40 index and in credit spreads

In basis points



Sources : Bloomberg, Banque de France

[2] *These assumptions are those necessary for a Black and Scholes-type model,* i.e. *the value of the firm is modelled by a geometric Brownian motion (random pattern) with a trend equal to the short-term risk-free rate and a constant standard deviation (volatility) in the most simple case.*

- *Volatility of the asset value of a firm.* As for any option valuation, volatility is an essential variable. Indeed, if we assume that the default occurs at maturity, the higher the volatility of the asset value, the greater the likelihood, at this date, that this value will be lower than that of the firm's debt. Logically, the spread, which corresponds to the additional yield, increases along with the risk, measured here by the volatility. The problem is that the value of the firm's assets, and *a fortiori* its volatility, cannot be directly observed. The solution adopted for testing this type of model consists in replacing this volatility by that of the firm's share price, which is undeniably easier to measure. The impact of volatility on the level of spreads should be seen in the light of two considerations:

  - First, the impact of applying the full fair value accounting principle to balance sheet analysis is not neutral in terms of the size of spreads. If we apply, for example, the above rationale to financial intermediaries, the widespread application of the full fair value accounting principle, *i.e.* marking-to-market an increasing number of balance sheet items could result in greater volatility of firms' assets and liabilities, and thus, all other things being equal, in an increased default probability and, ultimately, in a structural widening of credit spreads. Here, the question is not to ascertain whether fair value accounting is the most suitable approach for reflecting the value of the firm, but rather to stress the possible consequences arising from the increase in volatility in terms of the levels and variability of these spreads, or simply to pinpoint one of the limitations of the structural approach.

  - Second, the impact of share price volatility varies according to the creditworthiness of the company, *i.e.* its rating and type of assets: it seems that share price volatility has, ceteris paribus, a larger impact on the market value of the debt and hence on the spread for speculative grade companies than for investment grade companies; this can possibly be explained by the wider dispersion in spreads for lower-rated firms.

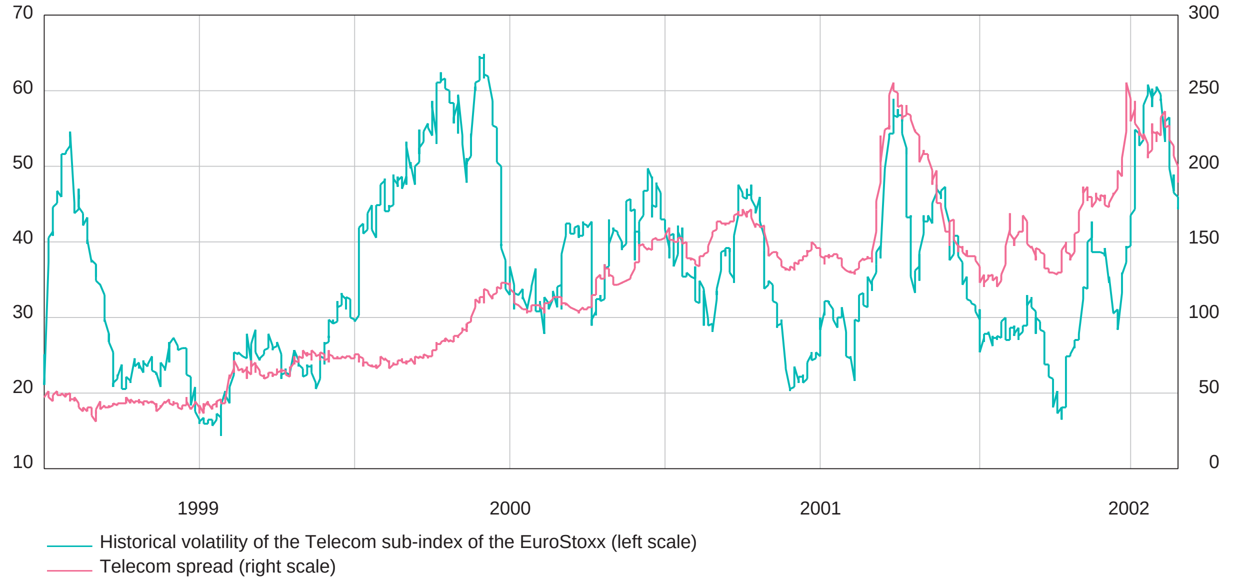
It is necessary to compare the same type of assets, and in particular to distinguish between tangible and intangible assets. Valuing intangible assets such as brands, consumer networks, etc. is a considerably more complex exercise than valuing tangible assets. In general, the valuation of intangible assets is less reliable, subject to more frequent revision and therefore more volatile. Yet the weight of intangible assets significantly increased in the second half of the 1990s due to the development of new information and communication technologies, which partly explains the higher variability of corporate bond spreads over the past few years.

The Telecom sector illustrates these dynamics particularly well. The volatility of telecom stocks remained moderately correlated with trends in the sector's spreads between 1994 and 2000. During this period, operators were very highly valued on the basis of extremely optimistic future profitability expectations. The situation changed as new economy stocks started to correct. The relationship between spreads and volatility then increased, as spreads widened following ratings downgrades in the sector, due to the sharp increase in the leverage effect.

However, the limitations of this type of model, in which the option is valued using Black and Scholes' model, are well-known to market practitioners: on the basis of a lognormal distribution of asset prices, it is not possible to take account of the asymmetry and the thickness of distribution tails (kurtosis). Furthermore, Merton's assumption that default can only occur at maturity is too restrictive; representing patterns in the value of the firm by a diffusion process does not allow for the possibility of a sudden fall in its value, and thus estimated default probability in the short term becomes negligible. Consequently, using this modelling technique, short-term credit spreads for investment-grade securities are likely to be almost zero, which is the contrary to the empirical evidence. Using a jump-diffusion approach yields more realistic results, but the modelling technique becomes much more complex.

Telecom spread and volatility of the EuroStoxx telecom sub-index

In basis points



Sources : JP Morgan, Bloomberg, Banque de France

1|2 "Reduced-form" approach: using default and recovery rates

In this approach, the credit spread between a risky bond and a risk-free bond corresponds to the additional yield required by investors to cover their risk of loss. The yield differential, which is contingent on the default and recovery rates expected by the markets, must theoretically compensate for the risk so that the expected yield of a risky bond is equal to that of a risk-free bond, assuming that investors are indifferent to risk, *i.e.* risk-neutral (see Appendix).

Contrary to structural models, reduced-form models do not explicitly relate the default to the firm's value, *i.e.* do not state the exact cause of default, and hence it is not necessary to estimate the parameters of the value of the firm in order to solve these models. Studies tend to favour this type of model because company default (bankruptcy) is a complex event for which the exact causes are often inaccurately specified, *i.e.* are either too restrictive or too vague. Another major difference is the degree of default predictability: the date of default is a random variable and is therefore totally unpredictable, which is not the case in structural models. Lastly, if we assume that the default probability varies over time and depends on the level of interest rates [3], these reduced-form models reflect the two essential characteristics of defaults, *i.e.* the probability of a default occurring and the recovery rate.

In this approach, the level and variation of the credit spread are contingent on the default and recovery rates expected by the markets, which are themselves directly influenced by business cycles. Furthermore, the level of risk-free interest rates has a significant impact on this spread. The problem is that, for some theoreticians, the interest rate effect is positive, in particular *vis-à-vis* the financial constraint that it represents for companies — high interest rates lead to increased vulnerability for indebted firms — and negative for others, as it results in, for example, a supply effect or crowding-out effect — since higher interest rates curb the supply of corporate bonds. Assuming demand remains constant, this results in a rise in prices, *i.e.* a narrowing of spreads. There is also a negative interest rate effect in the structural approach, where higher interest rates result in an increase in the firm's forward value (beyond the strike price), which reduces the default probability and thus contributes to narrowing the credit spread.

[3] *The first reduced-form models of Jarrow and Turnbull (1995) and Madan and Unal (1998) assumed that defaults were not correlated with interest rates.*

Why the credit spread should reflect the credit risk

By formalising the reduced-form approach, the link between the credit spread and the risk of loss can be expressed as follows:

For a given bond, p *denotes the default probability and* µ *the recovery rate in the event of default. As the bond price is equal to the discounted value of expected future cash flows, the price of a zero-coupon bond with nominal value* B, *will be equal to the discounted value* V *of the amount expected at maturity* M:

$$M = p.\mu.B + (1 - p).B \text{ and thus } M = [1 - p\,(1 - \mu)].B$$

Moreover, the yield r *required by a risk-neutral investor must be the same for a risky and a risk-free bond. Hence, for simplicity's sake, let us take a single period bond, and where*

V = *price of a one-year zero-coupon bond and* y *its spot rate, we obtain:*

$$V = B / (1 + y) = M / (1 + r) = \frac{[1 - p\,(1 - \mu)]\,B}{1 + r}$$

From this, we derive the following spread

$$y - r = \frac{p\,(1 - \mu)\,(1 + r)}{[1 - p\,(1 - \mu)]}$$

We see that the spread is a function of both the expected loss *(default probability and recovery rate in the event of default) and the* level of the risk-free interest rate.

To study a longer bond, p_i *denotes the marginal default probability of year* i *(or the marginal default rate) and* μ_i *the marginal recovery rate of year* i.

Thus, the average cumulative default rate up to year t *is:*

$$P_t = 1 - \prod_{i=1}^{t} (1 - p_i)$$

As the spread is expressed as a percentage/year, we calculate an average annual probability (rate) p *and a marginal loss* l_i:

$$p = 1 - [1 - P_t]^{1/t} \text{ and } l_i = p_i\,(1 - \mu_i)$$

The expected loss is therefore the cumulative average loss up to year t:

$$L_t = 1 - \left[\prod_{i=1}^{t} (1 - l_i) \right]$$

and the expected average annual loss:

$$l = 1 - [1 - L_t]^{1/t}$$

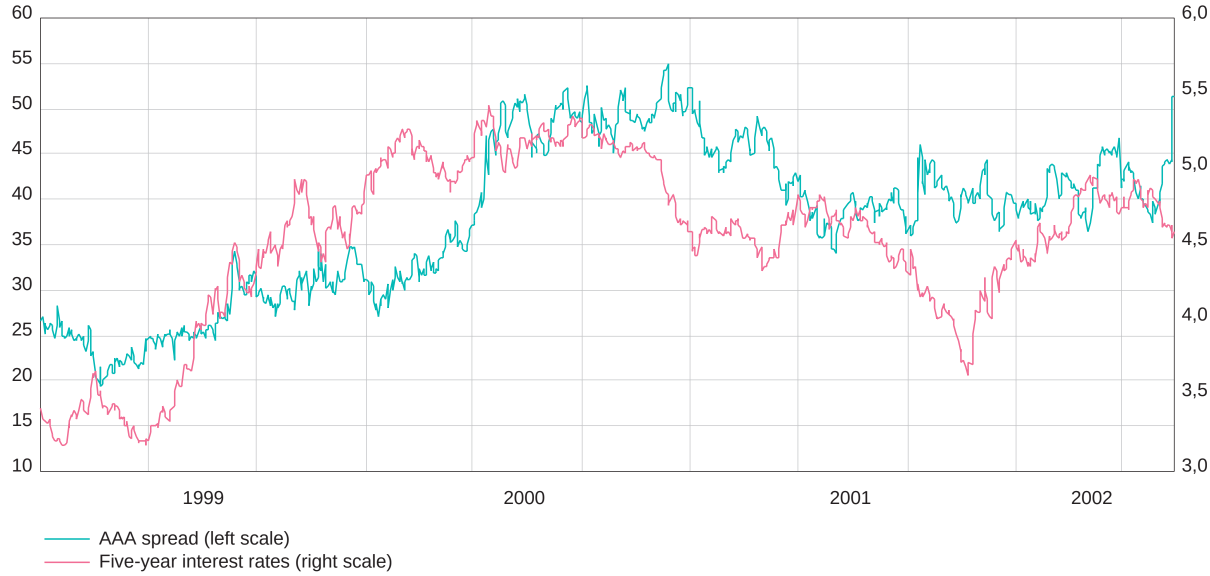
The credit spread is then:

$$y - r = \frac{p\,(1 - \mu)\,(1 + r)}{[1 - p\,(1 - \mu)]}$$

with µ = 1- l *and* y *and* r *denoting the spot rates corresponding to the maturity of the zero-coupon bonds used.*

Interest rates and AAA spreads in the euro area

In basis points *In %*



Source : Banque de France

The advantage of this type of approach is that it provides an *a priori* fairly simple valuation model for a risky bond and hence for the yield spread, derived from the following data: the price of a risk-free bond of the same maturity, the default probability and the recovery rate. The price of the risk-free bond is observed on the market, or interpolated from the term structure of the price of zero-coupon bonds, and the recovery rate can be estimated using historical data for similar bonds, such as those provided by international credit rating agencies (see table below), and for different ratings.

Cumulative default rate for the period 1983-2001

(as a %)

	One-year horizon	Five-year horizon	Ten-year horizon
Investment grade	0.06	0.96	2.21
Speculative grade	3.99	22.23	35.50
All corporates	1.34	7.24	11.07

Source: Moody's "Default and Recovery Rates of Corporate Bond Issuers", February 2002

Bond recovery rate for the period 1982-2001
by rating one year before default

(as a %)

	Investment grade	*Speculative grade*	*All ratings*
Secured bonds	73.44	52.76	53.32
Senior unsecured bonds	52.48	35.29	36.57
Subordinated debt	35.75	31.74	31.84

Source: Moody's "Default and Recovery Rates of Corporate Bond Issuers" February 2002

The difficulty resides in estimating the default probability, which is not the historical default probability but the risk-neutral default probability [4], *i.e.* the default probability adjusted so that that the expected yields on all bonds, risky and risk-free alike, are the same and equal to the risk-free interest rate. This probability may be interpreted as a probability adjusted for the default risk premium paid to the investor. This premium corresponds to the price differential between a risk-free bond and a risky bond divided by the expected loss, *i.e.*

$$\text{Premium} = [V_G - V_{Ci}] / [V_i(1-\mu_i)p_i]$$

where V_G is the price of the risk-free bond
V_{Ci} is the price of the risky bond with rating i
μ_i is the recovery rate for rating i
and p_i is the historical default probability

[4] *We use a risk-neutral valuation approach as we assume that investors are risk-neutral,* i.e. *they have no preference for risky or risk-free bonds.*

The adjusted probability can then be estimated by multiplying the historical probability by this risk premium (see Jarrow, Lando and Turnbull 1997).

Reduced-form models nevertheless have two main limitations:

- for bonds with specific clauses relating to the rating, such as bonds with embedded triggers, changes in the rating become fundamental in valuing their prices as these clauses result in changes in the cash flows from these bonds. A more complex modelling technique is then required (see article on contingency clauses);

- these models do not take into account the systematic risk of bond portfolios, *i.e.* that the defaults of different firms are correlated and coincide with fluctuations in the business cycle.

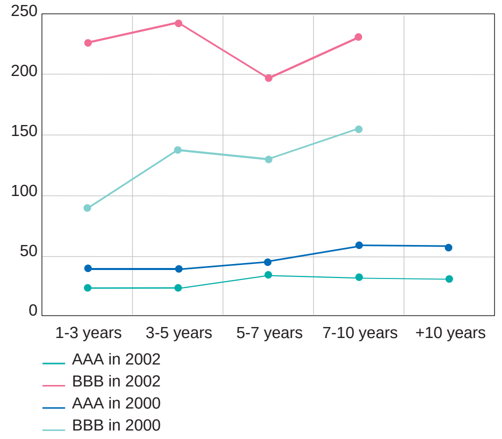
1|3 Term structure of spreads and ratings

Another important theoretical aspect, analysed by two modelling approaches, is the shape of the term structure of yield spreads. Using Merton's approach, this structure may vary in shape depending on the value of the firm's debt/asset ratio: while this ratio remains below one, the term structure of spreads is upward sloping (or hump-shaped), but inverts when the ratio is equal to or over one. This can be explained by the following: the value of the bond depends on the default probability which in turn depends on the value of the firm. For a given debt, the higher the value of the firm, the lower the default probability and, in principle, the higher the firm's rating. Yet, with a high rating, such as AAA or Aaa, there is an asymmetry effect given that, as the default probability is already low, the potential for improvement is minimal, whereas the potential for the firm's situation to deteriorate is much greater, and therefore the default probability increases along with maturity. The term structure of spreads is therefore (slightly) upward sloping. Conversely, with a low rating at issue, such as Cc or C, the potential for improvement is equal to or greater than that for deterioration. The longer the bond, the higher the value of the firm (assuming that it survives), which could explain the inversion of the term structure of spreads. Lastly, for firms with intermediate ratings, the short-term potential for deterioration is predominant but is offset by the long-term potential for improvement, which is likely to result in a hump-shaped spread curve.

The chart below confirms this theory for risky AAA-rated bonds, but is less clear for BBB-rated bonds (see Part 2).

Term structure of credit spreads, corporate bonds (euro area)

Spreads in basis points



Sources: Merrill Lynch, Bloomberg

NB : There is no significant index for BBB rated bonds with a maturity of 10 years.

The various econometric studies carried out on the term structure of spreads (Litterman and Iben 1991, Fons 1994 and Duffee 1999) converge towards the same result: for investment grade issues, the structure is upward sloping and this slope becomes steeper for lower-grade issuers. Conversely, for speculative grade issues, the results of the main studies diverge. Indeed, while authors such as Sarig and Varga (1989) and Fons (1994) find that, for these issues, the term structure of spreads is inverted, which corroborates Merton's findings, other authors, such as Helwege and Turner (1999), contest this inversion. The main argument put forward is that in the tests carried out there is a selection bias in the choice of maturities: among the firms with the same rating, the least risky tend to issue the longest bonds. Consequently, the average spread narrows as the maturity lengthens, while for a given firm the spread widens along with the maturity. Helwege and Turner avoid this problem by using a basket of bonds with different maturities for a given firm. The term structure of yield spreads is therefore likely to be upward sloping regardless of the issuer's rating.

A construction recipe for term structures of credit spreads

Litterman and Iben (1991) suggest constructing a term structure of credit spreads on the assumption that bonds have a higher default probability for the more distant maturities. Without supporting this assertion with economic theory, they posit a simplified iterative method for assessing these probabilities using yield curves for government and corporate zero-coupon bonds, assuming that the recovery rate is zero in the event of default.

For an investor, the expected yield of a risk-free bond (government bond) and a risky bond (corporate) is the same.

Let :
${}_0R_{iG}$ *denote the zero-coupon rate (spot) with maturity* i *of a government bond*
${}_0R_{iC}$ *denote the zero-coupon rate (spot) with maturity* i *of a corporate bond*
p_d *denote the default probability*
V_{ic} *and* V_{iG} *the prices of zero-coupon bonds with maturity* i.

For the first year, we obtain:

$$(1 + {}_0R_{1G}) = (1 + {}_0R_{1C}) \times (1 - p_d)$$
$$\text{or } V_{1G} = V_{1C} / (1 - p_d)$$
$$\text{hence } p_d = 1 - (V_{1C} / V_{1G})$$

For the second year, two-year bonds are used; the default probability obtained is a forward probability $p_{d\,f}$ *(between the end of period 1 and the end of period 2) and can only exist if a default has not occurred in the first year.*

Given that:

$$[(1 + {}_0R_2)^2 / (1 + {}_0R_1)] = (1 + {}_1F_2)$$

with ${}_1F_2$ *being the one-year forward rate*

$$\text{or : } V_F = V_2 / V_1$$
$$\text{hence : } p_{df} = 1 - (V_{FC} / V_{FG}) \quad \text{etc.}$$

With a default probability increasing along with the horizon, they find the term structure of spreads to be upward sloping, as do most of the authors who have analysed this structure.

2| Credit risk: the limitations of empirical analysis

On the basis of these main theoretical approaches, practitioners have developed more operational models for managing default risk such as KMV-type models, derived from the structural approach, and "maximum loss" models such as Value at Risk, e.g. J.P. Morgan's "Creditmetrics". All of these models however encounter a number of difficulties, not least of which is accurately measuring spreads using market data. Above and beyond these difficulties, the most important issue is to assess the true information content of credit spreads and to assess the contribution of the default risk variable in the various explanatory variables of yield spreads.

2|1 The problems involved in measuring spreads

While it appears simple to calculate the yield spread between corporate and government bonds, this spread depends firstly on the type of rate used (the yield to maturity or the spot rate) and secondly on the availability of the representative rate, which in turn depends on the liquidity of the bonds used. Moreover, historical variations in the yield spread are affected by the instability of credit agencies' ratings.

Biases resulting from the use of different rates

The most simple method for obtaining a credit spread is to calculate the difference between the yield to maturity of a corporate bond and that of a government bond of the same maturity. However, the spread obtained in this way is only an approximate measurement of the true credit spread since it will also depend, as with all yields to maturity, on the coupon size of the chosen bonds. In other words, by directly comparing two bonds with the same maturity, we are in fact comparing two bonds that have neither the same duration (price sensitivity to interest rate changes), nor the same convexity (sensitivity to the slope of the yield curve). Calculating spreads on an aggregated basis using bond indices is subject to the same difficulties.

Empirical studies aiming to obtain a more rigorous measurement of spreads use two kinds of method:

- They either calculate the modified duration [5] of bonds and, where necessary, the option adjusted duration for bonds with an embedded option; the spread then corresponds to the difference in the yield to maturity between bonds with the same duration, which makes it possible to partially offset the coupon effect on the yield to maturity. This solution is closer to that used by market participants: the decline in Treasury bond outstandings as of 1997 steadily prompted players to quote spreads against the swap yield curve instead of yield to maturity spreads. As swap rates correspond to the yield to maturity at par [6], this approach makes it possible to measure spreads correctly for corporate bonds issued at par, or close to par. We should however stress two limitations: first, if the price of corporate bonds is far from par, the spread becomes approximate. Second, bonds with the same duration may have different convexities and therefore different interest rate curve risks.

- Or they use a zero-coupon rate curve (spot rate) for both government and corporate bonds. The major drawback is that this requires that rates be estimated using techniques that are relatively reliable but onerous to implement. The advantage of using this approach is that yield spreads can be measured more accurately.

In order to calculate these rates, the bond prices used are those of the latest transactions or the most recent bid prices. Irrespective of the type of rate used, and despite the considerable growth of the corporate bond market — with the nominal outstanding for the euro area totalling EUR 2,690 billion at the end of 2001, *i.e.* half that of the US market — the lack of liquidity on certain bonds introduces another bias into the data used: either there are not enough quotations, or the prices quoted are not significant (no transactions for a long time). These prices should thus be estimated by interpolation, or using a price matrix, taking high-grade bonds with similar ratings, sectors and durations.

[5] *The modified duration is equal to the duration divided by the interest rate factor (1 + R).*
[6] *The swap rate corresponds to the coupon in such a way that the price is equal to par,* i.e. *the coupon equals the yield to maturity.*

Ideally, a term structure of rates corresponding to the term structure of the default probability should be obtained. This structure varies from one issuer to the next, and only governments, and a few very large issuers such as mortgage agencies, have sufficient borrowing capacity to issue on all maturities. The best solution is therefore to group issuers from the same sector and with the same rating and only use plain vanilla bonds, or callable or puttable bonds provided that option adjusted spread is calculated. However, even borrowers issuing in the same currency with identical ratings and maturities may incur different borrowing costs. For example, the graph below shows that even AAA sovereign issuers are subject to rate differentials.

The paper by Elton and *al.* (2001) on the US market for AAA to BB-rated bonds over the period 1987-1996 allows us to corroborate some conclusions drawn from theoretical analyses: the corporate spread is wider for lower-grade issues regardless of their maturity; the financial sector spread is wider than the industrial sector spread for all maturities and ratings. Above all, we observe an upward sloping spread curve for investment grade bonds, consistent with the models of Merton (1974) and Jarrow and *al.* (1997), and a hump-shaped structure for BBB-rated industrial bonds, also consistent with the results obtained using these models and those and Sarig and Varga (1989) and Fons (1994) [7].

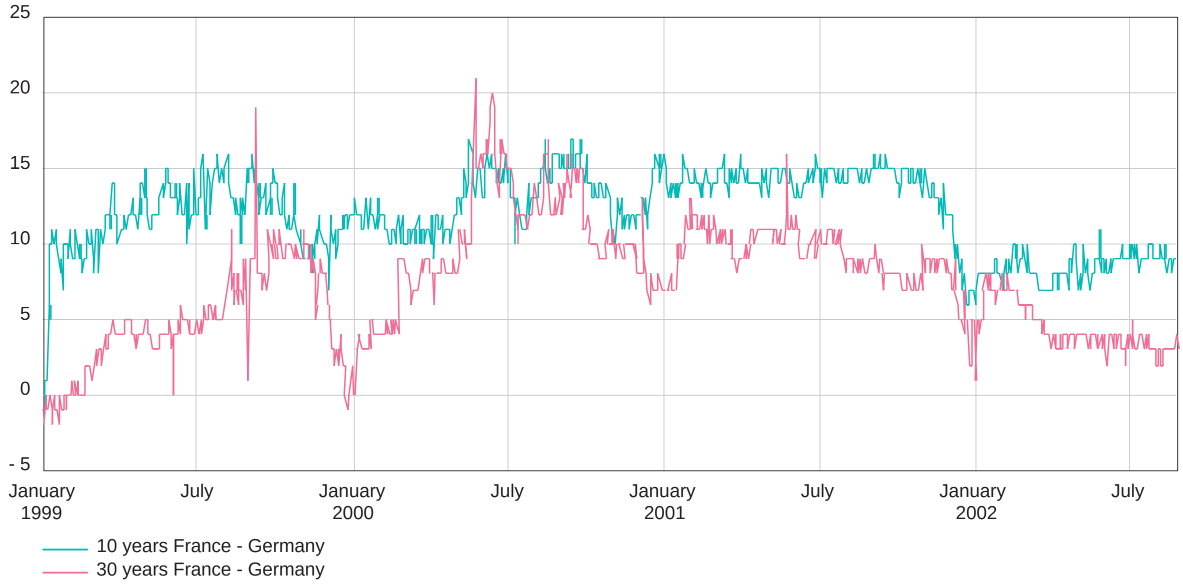
The instability of ratings

Using reduced-form models, the value of risky bonds is obtained using the price of a risk-free bond of the same duration, the risk-neutral default probability and the recovery rate in the event of default on the risky bond (see section 1|2). The difficulty in valuing risky bonds arises from the fact that this default probability does not correspond to the historical default probability of a rating category because the latter may, for a given bond, by revised during the bond's life. It is therefore necessary to use the transition probabilities of ratings based on historical data, which are also provided by credit rating agencies.

However, these matrices are themselves unstable over time. For example, this can be observed by simply comparing the average percentage over a one-year horizon for two different periods: according to Moody's (2002), 89,09% of issues remained Aaa for the period 1970-2001 compared with 85% for the

Long-term French and German rate spread

In basis points



Source: Banque de France

[7] *Provided that the BBB rating is considered to be a low-grade issue (see Section 1.3, the refutation of this result by Helwege and Turner 1999 explains that this result is due to the selection bias relating to the issuance maturity).*

Transition matrix for period 1970-2001

Over an average horizon of ten years

(as a %)

New *rating :*	Aaa	Aa	A	Baa	Ba	B	Caa-C	Default	Withdrawal
Initial Rating									
Aaa	31.28	28.22	9.63	2.61	0.85	0.11	0.05	0.71	26.55
Aa	5.23	28.56	28.55	7.86	2.46	0.52	0.10	0.97	25.75
A	0.39	10.49	38.87	15.24	4.32	1.59	0.20	1.37	27.52
Baa	0.17	2.62	17.43	26.23	8.10	2.91	0.23	3.77	38.53
Ba	0.23	0.76	5.62	11.54	11.32	6.90	0.54	14.34	48.74
B	0.05	0.01	1.79	4.23	9.22	9.65	0.48	27.83	46.74
Caa-C	0.00	0.00	0.00	4.49	1.60	1.70	2.36	53.16	36.70

Source: Moody's "Default and Recovery Rates of Corporates Bond Issuers", February 2002

period 1983-2001, and 62.90% and 54.21% respectively for the Caa-C, which seems to indicate a lower stability of ratings. In this respect, it is interesting to note the growing asymmetry between the number of ratings downgrades and upgrades: in 1970, Moody's downgraded 21 US bonds and upgraded 23, while in 1990, it downgraded 301 and upgraded only 61 [8]. This growing asymmetry has been observed for both investment grade and speculative grade bonds.

There are two possible interpretations for this: either the creditworthiness of US firms has recently declined, or ratings criteria have become stricter, *i.e.* a lower rating for the same ratios. In order to interpret this data accurately, it is necessary to carry out an in-depth analysis of both changes in companies' financial and accounting ratios over time and changes in the behaviour of credit rating agencies in terms of how they use publicly available information to set their ratings. Blume, Lim and Mackinlay (1998) carried out a study of this nature for the period 1978-1995 and concluded that ratings criteria have become stricter, assuming however that agencies do not have access to private information and that the interpretation of these ratios has not changed over time.

Overall, the instability of ratings — reflected by transition matrices — together with the instability of these matrices and the stricter rating criteria, makes it more difficult to estimate default probabilities. The technical difficulties involved in measuring credit spreads and the fact that most market participants accept an approximate measurement make interpreting these spreads even more delicate.

2|2 The information content of credit spreads

Assuming that we have resolved the problem of measuring credit spreads, we still have to check that these spreads actually offset the potential loss on risky bonds so that, for a risk-neutral investor, the return on risk-free bonds is the same as that on risky bonds. In other words, do yield spreads reflect default risk — default probability with a given recovery rate — or do they contain other explanatory factors?

Whether we use structural models or reduced-form models, it appears that spreads estimated on the basis of default risk do not correspond to the yield spreads measured, *i.e.* to credit spreads:

- Merton-type structural models generate spreads that are much narrower than those observed empirically, and very short-term spreads that are almost zero, which is also not the case in reality.

- Despite the fact that reduced-form models use marginal default rates estimated by means of transition matrices and recovery rates, they do not explain the differences in spreads between bonds with different ratings given that lower-grade bonds are less liquid (see below). Yet, the liquidity premium is an essential factor in yield spreads.

Above and beyond the usual criticisms that can be made of the models themselves and their implicit assumptions — perfect capital markets, continuous

[8] *The increase in the absolute number of rating revisions is due to the substantial rise in the number of corporate issues, and thus we should focus on the ratio between downgrades and upgrades.*

trading, no sudden price changes, etc. — these results should be interpreted bearing in mind that default risk is only one part of the credit spread. We should therefore consider the other components of this spread and ask ourselves whether risk-neutral investors really exist and whether a systematic risk premium is included.

The spread between the credit and the default spread

The empirical study by Delianedis and Geske (2001), which is based on the structural model, reveals that default risk only accounts for a small proportion of the credit spread, confirming the results obtained by Elton, Gruber and *al.* (2001) using the *reduced-form* model. Drawing on monthly data from November 1991 to December 1998 on US corporate bond prices, Delianedis and Geske measured the residual spread between the credit spread observed and the default spread calculated. Their model included the possibility of partial recovery and tax effects that are specific to the United States.

These figures show that the residual spread accounts for between 95.4% for the AAA and 77.7% for the B of the credit spreads. Consequently, for investment grade firms, the main part of spreads is not accounted for by default risk, and the higher the grade the smaller the proportion of default risk. Admittedly, the value of default spreads depends on the recovery rate used (65% in the table above), but the sensitivity is relatively low: by moving this rate from 100% to 0%, the default spreads widen from 1 (17) to 8 (72) basis points for the AAA (and BBB respectively). This sensitivity is likely to be much greater for speculative grade bonds that have a higher default probability.

The values obtained for the default spreads calculated — and hence implicitly the residual spreads — are also sensitive to those used for constructing structural models. For example, the volatility of the stock (a proxy to the firm's assets) would have to rise by over 100% in relation to the observed volatility in order to explain the residual spreads in the jump-diffusion model. In other words, other explanatory factors must be sought. In this respect the following variables should be considered: the interest rate, the term premium, the return on equity, the stock market risk, the systematic risk premium and, above all, bonds' liquidity.

The essential role of liquidity

The results of econometric studies testing the influence of these different factors (Ericsson and Renault 2001, Delianedis and Geske 2001, Houweling and *al.* 2002) concur on at least one point: the liquidity factor plays a fundamental role in explaining the level of credit spreads, via the residual spread.

While there is no doubt as to the role played by liquidity, its impact on yield spreads depends on the indicator used to measure liquidity. Houweling and *al.* set out to measure the liquidity premium between two corporate bond portfolios in euro, one comprising the most liquid bonds and the other the least liquid, using four different liquidity criteria: issue size, the age, number of quotations and dispersion of quotations. For the period January 1999 to May 2001, they obtained a premium of 0.2 basis points when the liquidity was measured simply by issue size, but a premium of 14 basis points when it was measured by the number of years since the issue date, 27 basis points measured by the number of quotations and 47 basis points measured by the dispersion of quotations!

Credit, default and residual spreads, (Delianedis and Geske, 2001)
November 1991 – décember 1998
(in basis points)

Rating	Firms	Credit spread		Default spread		Residual spread	
		Median	Standard deviation	Median	Standard deviation	Median	Standard deviation
AAA	18	35.5	13.3	1.6	3.1	33.9	14.18
AA	71	47.6	10.3	2.9	8.2	44.7	9.51
A	193	70.0	14.5	11.4	19.8	58.6	19.27
BBB	188	117.1	25.4	26.1	52.3	91.0	34.79

NB: The standard deviation of the default spread shows that the default spread varies considerably for issuers with the same rating. A sectoral breakdown would probably make it possible to obtain lower standard deviations.

Delianedis and Geske, in an attempt to explain the residual spread, propose a more original measurement of liquidity: they use the monthly volume of transactions of equities corresponding to the bonds, which they justify by the fact that, in order to hedge a corporate bond, government bonds are necessary to hedge the interest rate risk but equities are also necessary to hedge the default risk. The negative relationship between the variation of the residual spread and the variation of liquidity logically increases as the rating decreases (it is not really necessary to hedge a AAA-rated bond with equities). Furthermore, it is only statistically significative for lower-grade bonds, and the authors therefore conclude that an increase in liquidity results in a narrowing of the residual spread, and, more specifically, in a narrowing of the credit spread, without affecting the default spread.

Ericsson and Renault test the following two assumptions for the period 1986-1996: liquidity premiums are higher for risky bonds and the term structure of liquidity premiums is downward-sloping. Their results confirm that liquidity does indeed have its expected impact. On average, a recently issued bond (*i.e.* less than three months) has a spread of 14 basis points below that of older bonds. This spread widens as the rating decreases: it is 11 basis points for high-grade bonds, but 33 basis points for bonds with a low rating. As regards the term structure of liquidity premiums, the authors obtain a fundamental result: it is downward-sloping, which explains the flat credit spreads for high-grade bonds found by Duffee (1999), whereas the models give an upward-sloping term structure of credit spreads for low risk bonds. The term structure of default spreads is upward-sloping but these spreads only account for a small proportion of credit spreads, and when we add the decreasing liquidity premiums, a flat term structure of credit spreads can be obtained.

Other explanatory factors

The systematic risk premium

Why should credit spreads include a risk premium of this kind [9]? As returns on corporate bonds are more risky than those on government bonds, investors naturally require a risk premium since a large part of the risk is systematic, and therefore by definition cannot be diversified: corporate bond yields vary systematically with those of other risky assets such as equities, while factors affecting equities do not affect the yield on government bonds. Theoretically, the expected loss on a corporate bond is negatively related to equity prices because when the latter rise default risk declines. Therefore there is, *a priori*, a systematic component in corporate spreads. Indeed, E. Pedrosa and Roll (1998), on the basis of sixty bond indices (5 maturities, 4 sectors and 3 ratings) over the period October 1995 to March 1997 using daily data, find that time series of credit spreads are co-integrated [10], suggesting that their non-stationary nature can be attributed to common underlying factors. Elton et al. (2001), who focus on the important role of systematic risk, and do not take into account the liquidity factor, put forward an additional explanation for the existence of this risk: the risk premium required by investors varies over time according to their degree of risk aversion and affects both risky bonds and equities alike, thus increasing the systematic component of risk.

The influence of stock prices and their volatility

The stock market plays an important role in two ways: first, a rise in prices, *i.e.* a positive return on equity, is associated with a decline in the default probability due to the decrease in leverage effect and hence with a narrowing of default spreads; second, an increase in stock market volatility, used as a proxy to volatility of the firm's assets in the structural model, is associated with a rise in the default probability and hence with a greater default risk.

[9] *This question is no longer asked for equities as it is well-known that they entail a specific risk and a market risk known as the systematic risk.*

[10] *Broadly speaking, co-integration implies that there is a long-term stable relationship between non-stationary series,* i.e. *series that do not return to their average value following a shock.*

Whether theoretical or empirical, most studies raise the implicit, but nevertheless fundamental, question as to the relationship between credit spreads and stock prices. Such a link would justify the existence of a degree of interdependence between equity markets and bond markets, which could contribute to increasing financial instability. However, this relationship is subject to some uncertainty. In this respect, we should emphasise two important points: first, it is difficult to measure credit spreads accurately and, second, it appears that the liquidity premium (and not the default premium) constitutes the main explanatory variable of these spreads.

It is therefore important to be cautious when interpreting the value of or variations in these spreads, as the credit given to credit spreads is not without default risk!

Appendix:

Some intuitive elements regarding the valuation of risky assets using risk-neutral probabilities

We know that the price of an asset is simply equal to the sum of the discounted value of future cash flows. The difficulty lies in the fact that these flows are only known with certainty for a "risk-free" asset: irrespective of the state, these flows will be the same. However, these flows will differ for a risky asset, and will have to be estimated using default probabilities, transition matrices and the recovery rate.

Let us take, for example, two bonds with a maturity of one year with two possible states at this maturity: one risk-free, with a redemption value (face value) of one euro, irrespective of the state; the other, risky, with a redemption value of two euro in state A and three euro in state B. The price of the risk-free bond is 0.95 euro and that of the risky bond is 2.4 euro.

Furthermore, let us assume that the present value of a euro in state A equals V_A and that of a euro in state B equals V_B. Intuitively, we understand that $V_A + V_B$ is equal to the present value of one euro in one year irrespective of the state, in other words, equal to the price of a one-year risk-free bond with a face value of one euro.

As there are no arbitrage opportunities, there is a relationship between V_A, V_B, the future cash flows of the two bonds and the present value — the price — of these assets:

$$1V_A + 1V_B = 0{,}95 \text{ and } 2V_A + 3V_B = 2{,}4$$

Hence: $V_A = 0{,}45$ and $V_B = 0{,}5$

It is also possible to re-write these equations to obtain the risk-neutral valuation, *i.e.* so that the expected yield on each bond is equal to the risk-free interest rate:

$$(V_A + V_B) \text{ x } [V_A/(V_A + V_B) + V_B/(V_A + V_B)] = 0{,}95 \text{ and}$$
$$(V_A + V_B) \text{ x } [2V_A/(V_A + V_B) + 3V_B/(V_A + V_B)] = 2{,}4$$

let $q_i = V_i/(V_A + V_B)$ with $i = A$ or B

q_i may be interpreted as a probability since it is positive and since $q_A + q_B = 1$

Yet, the yield R on the risk-free bond is such that: $1 + R = 1/(V_A + V_B)$ = future value/present value (*i.e.* R = 5.3%)

We can therefore write:

$$[1/(1 + R)] \text{ x } (q_A + q_B) = 0{,}95 \text{ and}$$
$$[1/(1 + R)] \text{ x } (2q_A + 3q_B) = 2{,}4$$

Thus, if investors are risk-neutral, the yield on each bond is equal to the risk-free interest rate and the price of a risky bond is equal to:

$$V_t = [1/(1 + R)] \text{ x } E_q(V_{t+1})$$

This is why *q_A and q_B are named risk-neutral probabilities* (which are not the probabilities of occurrence of the two states). And for this reason, in order to value risky assets, it is necessary to adjust the historical probabilities of default and the recovery rates with transition matrices in order to obtain the risk-neutral probabilities.

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