The nature of credit risk:

the effect of maturity, type of obligor, and country of domicile

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Credit is the largest element of risk in the books of most banks and failures in the management of credit risk, by weakening individual banks and in some cases the banking system as a whole, have contributed to many episodes of financial instability (see Kaminsky and Reinhart (1999)). A greater understanding of the nature of credit risk, leading to improved measurement and management, would help to strengthen the international financial system.

AN INCREASING amount of research on credit risk is being carried out within financial firms, central banks, regulators, and universities. In the case of firms, the chief aim is to improve pricing of credit exposures and to create better systems for internal capital allocation. The authorities are motivated by the objective of developing regulatory capital requirements for credit books more closely aligned to risk than the arrangements set out in the 1988 Basel Accord. With the present broadbrush requirements the authorities can be less confident that firms are carrying adequate capital to cover their risks, with clear implications for financial stability. Also the closer the capital requirements are to the actual risks entailed in various exposures, the fewer the distortionary effects on behaviour and the less the effect on general economic efficiency.

There is evidence that some banks have been carrying out substantial amounts of regulatory arbitrage, using techniques such as securitisation, in order to use regulatory capital more efficiently, thereby increasing the average riskiness of the book relative to regulatory capital (see Jackson *et al* (1999) and Jones (1999)). In June this year, the Basel Committee on Banking Supervision issued a consultative paper setting out two possible methods for achieving risk-based requirements (see Basel Committee on Banking Supervision (1999a)).

This article summarises the current state of knowledge on several important aspects of credit risk. In this, we draw on the findings of a programme of research on credit risk, which has been pursued by the Financial Stability area of the Bank of England over the past few years. We also refer to the rapidly growing academic literature on credit risk and to research carried out by analysts at other public agencies. The focus throughout is on credit risks associated with large loan and bond exposures to corporate or public sector organisations. Credit risk associated with consumer loans, mortgage credit and lending to small enterprises is also clearly important but is beyond the scope of the present review.

We organise this article by, first, setting out some background discussion of credit risk and the setting of capital requirements, and, second, posing and suggesting preliminary answers to six key questions. These are: (i) What is the relative riskiness of credit exposures across different maturities? (ii) Does the nature of credit risk vary across different countries? (iii) Do credit exposures with the same rating behave differently depending on the type of borrower (sovereign versus non-sovereign, bank versus industrial or utility)? (iv) Do credit risk models successfully track risks associated with credit portfolios? (v) Are ratings by agencies such as Moody's or Standard & Poor's reliable? (vi) Does the credit risk of loans differ from that of bonds[1]?

1: An issue we do not discuss because of space constraints is the relationship between credit risk and market risk, most notably the risk of interest rate changes. Recent papers which have considered this issue include Longstaff and Schwartz (1995), Duffee (1999), Jarrow and Turnbull (1999), Morris, Neal and Rolph (1999), Kiesel, Perraudin and Taylor (1999b) and Leake (1999).

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Background

What is credit risk?

Banks are increasingly trying to assess not just average or expected losses through default by different types of counterparty but also how large their unexpected (or above average) losses may be. Some banks are looking at this for individual loans while others are attempting to assess risk for whole portfolios, allowing for correlations between different exposures.

The main components of credit risk are (i) the risk that a counterparty will default, and (ii) risks associated with the recovery rate given default. The pricing of loans reflects these risks in that the margin over the bank's funding cost should cover expected loss and remunerate economic capital set aside to cover the unexpected loss. Since credit losses are not evenly spread over the business cycle, a reserve may also be needed to cover expected loss in future years.

Traditionally, banks have assessed risks over the life of the exposure, concentrating on the likelihood of default at some date before the terminal repayment of a loan. But it is also the case that a deterioration in credit quality, even if no defaults have occurred, represents an economic loss since the current worth of the book is lower. In recent years, some banks have started to develop portfolio models to measure possible losses caused by changes in credit standing over a set holding period such as a year (which for most banks corresponds to the maximum period between credit assessments and adjustment of economic capital).

Banks assess risks by looking at past default rates for borrowers with characteristics similar to those of the obligor in question. To varying degrees, they also make use of external ratings issued by ratings agencies such as Moody's or Standard & Poor's. Many banks have formalised their credit assessments for counterparties by preparing their own internal systems of ratings which, in recent years, have been increasingly based on default probability or expected loss.

Setting capital requirements

Capital, whether economic or regulatory, should be sufficient to cover unexpected losses on exposures, over a given holding period, with a high probability. More conservative banks or those seeking a higher credit rating would choose a higher probability. Whether capital should also cover expected losses depends on whether banks maintain a separate reserve outside capital for this element of loss. The interest margin on loans should on average cover expected losses but this will not be true in all individual years[2].

When setting economic capital, banks need to know whether certain broad classes of exposure are riskier than others. For example, do short maturity exposures generally exhibit lower risk than long term? As another example, does the credit standing of certain types of counterparty show more volatility than is the case for others?

Similar issues arise for the authorities when setting the capital requirements for bank credit exposures. If capital requirements are set by the authorities, a central issue is whether particular types of exposure show similar risk characteristics and should therefore be assigned the same capital. If requirements depend on the assessment of risk by in-house models developed by the banks according to parameters set by the authorities, then the authorities need to understand whether or not the models are accurate and to consider how best to base capital requirements

2: There is a debate at present on whether banks should move to fair value accounting on the banking book. There are some difficult measurement issues but fair value accounting should in principle ensure that expected losses are fully recognised and are adjusted as credit quality deteriorates. One difficulty with fair value accounting would be finding a market price for illiquid loans. Any approach would have to reflect a bank's own assessment of expected losses.

on the output of the models. For this too an understanding of the nature of credit risk is essential.

Concerns about the state of development of credit risk models for portfolios of large corporate exposures led the Basel Committee on Banking Supervision to conclude that it was still too early to allow regulatory capital requirements to be based on the output of those models (see Basel Committee on Banking Supervision (1999b)). The Committee is now looking at ways of basing the capital requirements for credit books on internal ratings systems developed within banks. Individual exposures might be slotted by a bank into bands based on some concept of likelihood of loss such as default probability, with capital requirements for the exposures in the bands set according to the relative risks. Such an internal ratings-based approach would be an alternative to a 'standard' approach in which capital requirements for some exposures would be tied to the external ratings of the obligor made by, say, a ratings agency.

Both alternative and standard methods require an understanding of the structure of credit risk – how the risk for single exposures with a given rating varies across different types of borrower, different country of domicile and different maturity.

Indicators of relative riskiness

There are several possible indicators of the relative riskiness of different classes of exposure. One measure of perceived riskiness is the spread over the default-free interest rate that the market demands of particular categories of obligor. Spreads reflect perceived default probability and expected loss given default.

Spreads are not, however, an ideal measure of relative credit risk because the relative yields on two marketable instruments such as a bond will also be affected by issues such as market liquidity for each bond, risk premia etc.

The way in which spreads can be used as indicators of risk depends on the issue being considered. A comparison of the level of spreads will provide an indication of relative credit risk, subject to the above caveats, but if one wishes to compare risk over say a one-year holding period, it is the relative volatilities in spreads, i.e., the degree to which credit standing fluctuates, which matters. Again, liquidity and risk premia cause problems since they affect spread volatility.

A second measure of credit risk and perhaps the most direct is the default probability for particular types of borrower calculated from long runs of historic data. Drawbacks of this approach include the fact that, until the 1980s, relatively few ratings were sought by obligors other than US corporates. The larger banks are mobilising their own data to improve their loan pricing and capital allocation, but this data remains proprietary and confidential.

Default probabilities do not, however, capture the risk that a bank might experience an economic loss through a deterioration in the quality of the loan book rather than outright default. A more complete picture may be obtained from probabilities of ratings changes, termed ratings transitions. Such transition probabilities constitute the third measure used in the article. Like default probabilities, these probabilities may be calculated from long runs of data supplied by the US ratings agencies. They, therefore, suffer the same disadvantage in that they are a much richer source of information on US obligors than non-US.

In calculations of credit risk for portfolios of exposures, the statistic which has become almost the industry standard measure is the value at risk. Value at risk (VaR) is defined as the loss which will be exceeded on some given fraction of occasions (the confidence level) if a portfolio is held for a particular time (the holding period). In estimation of credit risk, it is common practice amongst banks to employ long holding periods (one year or more) and small confidence levels (1 per cent, 0.1 per cent or even less).

VaRs may in fact be calculated either for individual exposures or, allowing for correlations, for portfolios. Some VaR methodologies (such as J P Morgan's CreditMetrics) are driven by ratings transitions. Market spreads play a role but are assumed to be constant. Other VaR approaches use Merton models based on equity and liability data and are therefore affected by securities market conditions. VaRs are the fourth measure of relative credit risk used in the paper.

The final three measures of relative credit risk are the most satisfactory and reflect direct observation of the evolution of credit standing for particular types of obligor. It is nonetheless necessary to supplement these measures by looking at spreads because of the limited data available on ratings for certain types of borrower.

Questions on credit risk

Does the riskiness of credit exposures depend on maturity?

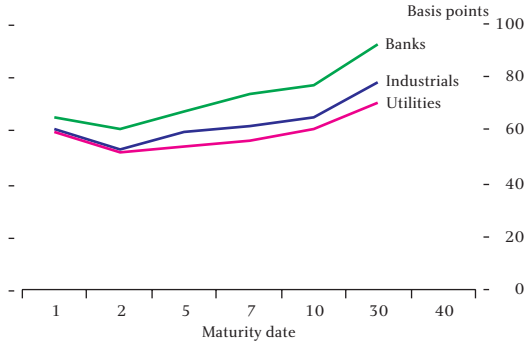
An important question for banks and regulators assigning capital to credit exposures is whether there is a significant maturity structure to credit risk and in particular whether shorter-maturity exposures should carry less capital than longer-maturity exposures. The current Basel Accord has a maturity dimension for interbank exposures but not for other types of exposure.

If the horizon over which one wishes to evaluate risk coincides with the maturity of the debt then a reasonable measure of risk is the credit spread times the maturity of the exposure in question[3]. The fact that the spread is multiplied by maturity means long-maturity exposures are likely to be riskier than short maturity. If the spreads themselves are on average upward (or downward) sloping in maturity, this would accentuate further (or mitigate) the effects of maturity.

Empirical work undertaken by Sarig and Warga (1989) suggest that credit spreads are upward sloping in maturity for investment-quality bonds but negatively sloped for high-yield bonds. Practitioners (see, for example, Litterman and Iben (1991)) often argue that credit spreads are generally upward sloping in maturity. A recent paper, Helwege and Turner (1999), eliminates sample selection problems in the Sarig and Warga study and shows that credit spreads increase with maturity for both high and low credit qualities.

Charts 1 and 2 show spreads over US Treasury yields, taken from Bloomberg (averaged over the period 1991 to 1999), for US industrials, banks and utilities of different credit ratings. For all credit qualities, the term structures are broadly upward sloping although there is a slight downward slope between one and two years. Estimation of defaultable bond term structure is notoriously difficult for short maturities when liquidity effects become important (see Perraudin and Taylor (1999) for a discussion) so the negative slope at the short end is unlikely to be a reliable feature of the data.

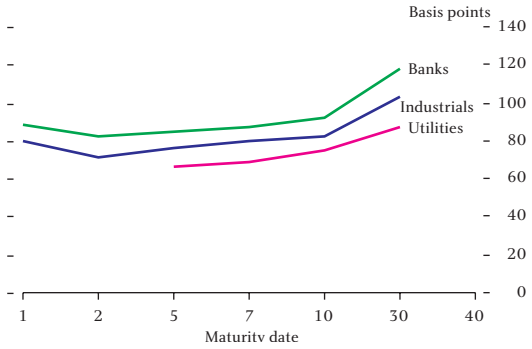
Chart 1:
A rated bonds, average spreads[(a)]



Source: Bloomberg.

(a) Sample period: 26 Sept 1991 to 20 Sept 1999.

Chart 2:
BBB rated bonds, average spreads[(a)]



Source: Bloomberg.

(a) Sample period: 26 Sept 1991 to 20 Sept 1999.

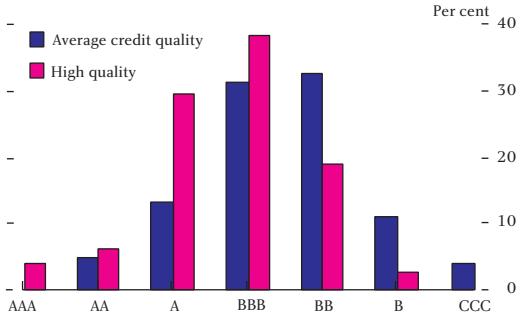
As discussed above, however, spreads are only one indicator of risk and are not ideal. Kiesel, Perraudin and Taylor (1999a) dealt with a number of the drawbacks of spread data by calculating VaR measures for portfolios of exposures. They employ a generalisation of J P Morgan's credit risk model, CreditMetrics, which uses transition probabilities as the main driver of the value at risk. Future spreads and hence future prices given particular ratings are assumed to be known. Correlations between ratings transitions are proxied using correlations between obligors' equity returns.

Kiesel, Perraudin and Taylor generalise CreditMetrics by allowing spreads for different ratings categories to change randomly. VaRs are calculated for a one-year holding period and a confidence level of 99.7% for portfolios of 500 exposures, each of equal face value. They focus particularly on VaRs for an 'Average

3: If one assumes for simplicity that the recovery rate in the event of bankruptcy is zero, for a defaultable pure discount bond with time to maturity, T, the probability of default before maturity, p, is equal to the spread, S, times maturity, T. In the period prior to maturity, the expected loss on the exposure per dollar invested is then p and the variance of the return due to default is p(1-p). As ST and hence p increases from a level of zero, the variability of the payoff therefore also increases (as p(1-p) is initially increasing in p).

Portfolio', the credit quality profile of which mimics that of the average portfolio of large US banks surveyed by the Federal Reserve Board (see Gordy (1999)). They also examine VaRs for a 'High Quality Portfolio' which resembles that of more conservative lending institutions included in the same Federal Reserve survey. The breakdown of the two portfolios is shown in Chart 3.

Chart 3:
Ratings profiles for US bank portfolios



Source: Gordy 1999.

Each VaR is divided by the expected value of the portfolio and multiplied by 100 and so is in the same units as a percentage capital requirement. Under reasonably standard assumptions about correlations between different exposures[4], VaRs for the Average Portfolio are close to the 8% capital charge specified by the 1988 Basel Accord[5] (see Table 1). The VaRs are slightly higher if spread risk is included as well as rating change and recovery risk. For the High Quality portfolio, VaRs are rather lower, being around 5%.

Kiesel, Perraudin and Taylor find that VaRs depend markedly on the average duration of the exposures included in a portfolio. This maturity effect is greater for high credit quality portfolios. For the average-quality portfolios, their calculations yield VaRs for exposures of two and ten-year maturity of 5.4 and 10.0, respectively. For high credit quality portfolios, the corresponding VaRs are 2.7 and 7.6.

An explanation for the somewhat flatter maturity profile of VaRs for lower credit quality exposures is a kind of survivorship bias. If low-rated obligors survive in the near term, their credit standing is likely to have risen in which case the market may believe that they will remain solvent for a long time. Another reason for the steeper profile for the high-quality exposures may be that the VaRs are an estimate of the likelihood that there will be a change in credit standing during the next year. With a prime-quality credit, it is more likely that information released within the year would point to problems at a later date rather than immediately. This would make a change in value of longer-term exposures more likely than shorter term.

Table 1: 99.7 per cent VaR

Portfolio	ρ	VaR Total	VaR Excluding spread risk
Average Quality	0.1	6.42	4.98
	0.2	8.51	7.62
	0.3	11.08	10.34
High Quality	0.1	4.06	2.65
	0.2	5.14	4.18
	0.3	6.43	5.75

Calculated using Moody's Data Transition Matrix (Nickell, Perraudin, and Varotto (1998))

Notes: Composition of the portfolios is explained in the text. VaRs are for a one-year horizon, in per cent of the expected portfolio value and are based on five-year maturity exposures. The total column shows VaRs which allow for spread risk, ratings transition risk and recovery rate risk. The right-hand column shows VARs reflecting only transition risk and recovery risk (like CreditMetrics). ρ is the correlation coefficient of the latent variables driving transitions.

Our discussion so far has focused on the effect of maturity on the riskiness of individual exposures. There is, however, a more marketwide, systemic, aspect to this issue, which affects the riskiness of lending to both corporates and sovereigns, but is, perhaps, particularly striking in relation to the latter. Although a single lender might experience lower risks if it concentrates its lending at shorter maturities, the same may well not be true of all lenders collectively. For example, in the case of countries, a sovereign borrowing short term and in a foreign currency may leave itself vulnerable to a liquidity crisis if market sentiment changes and lenders are unwilling to roll over short-term loans. The extent of the problem would, of course, depend upon the extent of the foreign-currency borrowing relative to, for example, the size of the country's foreign exchange reserves.

4: The calculation assumes that the correlation of equity returns is about 0.2. This figure equals the average of the off-diagonal correlations given in an example correlation matrix in the CreditMetrics technical document.

5: This calculation assumes a recovery rate of 51 per cent, which is in line with Moody's estimates of recoveries on senior unsecured bonds. Recovery rates for bank loans may well be higher, which would reduce the VaR in a roughly proportional way. Moody's reports a 71 per cent average recovery rate for bank facilities (for a discussion, see J P Morgan (1997)).

Does the nature of credit risk vary across different countries?

In designing capital requirements for credit exposures that will apply internationally, the next question is whether the riskiness of exposures to borrowers with a particular rating varies across countries? It is widely believed that the way in which ratings are constructed by the major ratings agencies delivers a comparable measure of the riskiness of obligors across countries. It is natural, however, to expect some difference in ratings transitions because the history of financial stability varies across countries; there are also differences in industrial structure and differences in the protection that insolvency legislation provides to creditors (see Wood (1991)). Empirical evidence on cross-country variation in credit risk is sketchy, largely because most data on credit risk come from the United States.

Nickell, Perraudin and Varotto (1999) examine rating transitions using the universe of Moody's senior, unsecured bond ratings (excluding municipals) from December 1970 to December 1997. Among other questions, they examine whether the ratings of obligors domiciled in the United States behave differently from those domiciled in Japan and the United Kingdom – ie, whether the volatility of ratings changes differs across these countries. Table 2 shows estimated, one-year transition matrices for obligors domiciled in each of these three countries[6]. The results in the table suggest that, broadly speaking, ratings transitions for UK and US obligors are similar but that ratings transitions for Japanese obligors are different. In particular, ratings for prime (AAA) Japanese companies were more volatile in the sample period examined by Nickell, Perraudin and Varotto, than in the United Kingdom and United States, whereas for other companies the ratings are more stable. This finding should be treated with caution, however, as the sample employed extends only to the end of 1997 and since then many Japanese companies have experienced ratings downgrades; but it does at least suggest that cross-country differences may exist.

Another way to measure whether obligations with a particular rating carry more risk in certain countries than in others is to examine bond-market spreads for obligors from different domiciles. Perraudin and Taylor (1999) extract spreads for different maturities and ratings categories from a large data set of US dollar denominated international bonds using McCulloch-style cubic spline techniques[7]. The spreads they obtain may be regarded as average spreads for obligors from particular ratings categories. By analysing the errors from the spline fits, one may gauge whether the debt of obligors of different types is priced differently from the debt of the average obligor from the same rating category.

Regressing the errors from the spline fits on a range of variables including dummies for different obligor domiciles, Perraudin and Taylor find that, allowing for rating, liquidity, seniority and some tax effects[8], spreads do appear to be affected by the domicile of the borrower. The effects are small, however. Bonds issued by AA-rated Japanese and European obligors are priced at a 10 basis point discount and a 4 basis point premium respectively compared with those of AA-rated US obligors. AAA-rated European bonds are priced at a 4 basis point premium compared with US AAA's while Japanese AAA-rated bonds are rated at a 4 basis point discount[9].

To summarise, the research carried out to date indicates that there may be some differences across countries in risks attached to borrowers with a particular rating. In particular, there is some evidence that Japanese ratings changes and spreads for given ratings differ from those of US-domiciled obligors. The magnitude and statistical significance of the differences is not entirely clear, however.

6: A ratings transition matrix consists of a matrix with as many rows and columns as the number of ratings categories (including default). A given (ijth) element represents the probability of going from the rating category associated with the corresponding row (ith) to the rating category associated with the column (jth) over a given period of time (in our case one year).

7: Bond prices may be expressed as the sum of principal and individual coupon payments each weighted by a discount function of the appropriate maturity. Cubic spline methods estimate the discount function by regressing bond prices on flexible 'spline functions' each of which is a function of time to maturity. This may be done either for a sample of default-free bond prices or for bond prices of a particular credit rating. The ratio of fitted discount functions extracted from defaultable and default-free bonds can be transformed to obtain an estimate of credit spreads.

8: They allow for rating, liquidity, etc by regressing the errors from splines fits for discount functions (see the last footnote) on domicile dummies as well as dummies for different seniority classes and liquidy proxies including the age of the bond and the size of issue. The regression coefficients on the domicile dummies, therefore, give a measure of the effect of domicile, holding the other influences constant.

9: The domicile effects on spreads are highly significant for AA and A-rated bonds but somewhat less significant for AAA-rated issues.

Table 2: Conditional transition matrix

United States

Initial rating	AAA	AA	A	BBB	BB	B	CCC	CC/C	Def	Number of issuer years
	Terminal rating									
AAA	91.9	6.9	1.1	–	0.1	–	–	–	–	1523
AA	1.2	89.3	8.8	0.5	0.2	0.0	–	–	–	4129
A	0.1	2.3	92.0	4.9	0.6	0.2	0.0	–	0.0	11282
BBB	0.0	0.2	5.5	88.9	4.5	0.6	0.1	–	0.1	9277
BB	0.0	0.1	0.5	5.4	85.5	6.9	0.3	0.0	1.4	7452
B	0.0	0.1	0.2	0.7	6.5	82.9	1.9	0.5	7.2	4128
CCC	–	–	–	1.0	2.5	7.6	67.3	3.5	18.1	315
CC/C	–	–	–	–	1.0	5.7	14.3	58.1	21.0	105

United Kingdom

Initial rating	AAA	AA	A	BBB	BB	B	CCC	C/CC	Def	Number of issuer years
	Terminal rating									
AAA	90.4	8.9	0.7	–	–	–	–	–	–	135
AA	0.3	88.2	11.0	0.5	–	–	–	–	–	390
A	–	3.4	94.1	2.5	–	–	–	–	–	444
BBB	–	–	11.9	86.4	1.7	–	–	–	–	59
BB	–	–	–	16.0	76.0	8.0	–	–	–	25
B	–	–	–	11.1	5.6	83.3	–	–	–	18
CCC	–	–	–	–	–	–	–	–	–	0
CC/C	–	–	–	–	–	–	–	–	–	0

Japan

Initial rating	AAA	AA	A	BBB	BB	B	CCC	CC/C	Def	Number of issuer years
	Terminal rating									
AAA	86.9	12.1	1.0	–	–	–	–	–	–	99
AA	0.3	88.9	10.5	0.3	–	–	–	–	–	306
A	–	0.8	95.2	4.0	–	–	–	–	–	396
BBB	–	–	1.2	96.9	1.6	–	0.3	–	–	322
BB	–	–	–	3.5	94.4	2.1	–	–	–	142
B	–	–	–	–	9.5	90.5	–	–	–	21
CCC	–	–	–	–	–	–	–	–	–	0
CC/C	–	–	–	–	–	–	–	–	–	0

Note: Data are notional unsecured Moody's long-term corporate and sovereign bond ratings between 31 December 1970 and 31 December 1997 measured on 31 December each year.

Do credit risks differ by type of obligor?

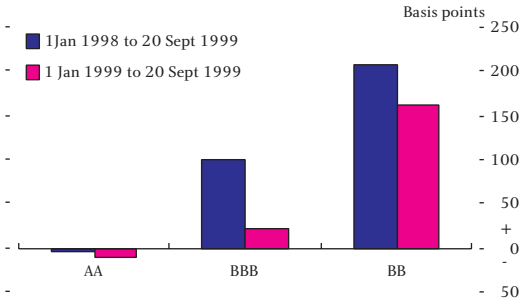
When deciding how to allocate capital to particular types of exposure, it is important to know if certain exposures should be grouped together, while others should be treated separately because of their different characteristics. Distinctions are frequently drawn between exposures to sovereigns, banks and industrials. Of particular interest are the questions: (i) are exposures to sovereigns less risky than those to non-sovereigns with the same rating, and (ii) are exposures to banks less risky than those to industrials?

The simplest source of information on these issues is data on spreads. Chart 4 shows the amount by which average daily Bloomberg spreads for US dollar denominated sovereign debt exceeded those on

US corporate debt of a similar rating in the past two years. Average credit spreads were significantly wider for BBB- and BB-rated[10] debt issued by governments than for US industrials with the same rating but this period was one of considerable turbulence in emerging markets, with problems in South East Asia and Russia. The chart also shows the difference between spreads on sovereigns and corporates for the rather more stable period of January to September this year. This shows a similar pattern, although the difference in the spreads is less marked, particularly for BBB bonds. However, the relatively small number of sovereigns in the sample (6, 6 and 8 for the categories BB, BBB and AA, respectively) make it difficult to draw firm conclusions.

The higher spreads may in part reflect market concerns about the outcome of problems on sovereign exposures. When a corporate defaults, its assets can be attached and it can be declared bankrupt, enabling legal action to be taken. This may mean that recovery rates on sovereign exposures are typically lower and less timely than those on corporates. Some rating agencies take loss-given default into account in the ratings but not all do so.

Chart 4:
Excess of average spreads on US$ sovereign bonds over spreads on US industrials[(a)]



Source: Bloomberg.
(a) Sample period: 1 Aug. 1998 to 20 Sept. 1999.

Another way to investigate the relative riskiness of different types of obligor is to study the behaviour of ratings transitions. Standard & Poor's one year transition matrices, calculated on ratings data from 1975 to 1998, suggest that exposures to sovereigns and non-sovereigns differ (see Standard & Poor's (1999a) and (1999b)) but in the opposite way from that indicated by the spread data. No rated sovereigns defaulted in this period although some renegotiated their external debt, or needed emergency IMF packages. And, in general, sovereign ratings appear more stable. One year transition matrices calculated by Bank of England staff from Moody's data covering the period 1970 to end-1997 also indicate that changes in ratings are less frequent for sovereign than for corporate obligors although the difference is less pronounced than in the case of the Standard & Poor's transitions.

These differences in ratings transitions partly reflect the fact that only a few sovereigns were rated in the earlier part of the sample period and all these were high quality. For example, in 1975, Standard & Poor's rated only seven countries: Australia, Austria, Canada, France, Japan, New Zealand and the United States. Even by 1990, there were only thirty one sovereigns rated by Standard & Poor's, of which only nine were from the emerging markets (Hong Kong, India, Israel, Malaysia, Singapore, South Korea, Taiwan, Thailand and Venezuela).

There is some evidence that ratings agencies find sovereign exposures more difficult to rate than industrials, perhaps indicating that there could be more uncertainty surrounding risk assessments for sovereigns and providing some justification for stickiness in ratings. Cantor and Packer (1995) find, when comparing Moody's and Standard & Poor's ratings, that there are greater differences in the ratings given by the two agencies to particular low credit quality sovereigns than is the case for low-quality corporates. This may reflect the short track record in rating lower quality sovereign exposures and the greater subjectivity in sovereign measurement – countries do not fail as such and whether payments are met depends in part on political will. There are also questions over adequacy of information released by some governments[11].

On the relative riskiness of banks and industrials, Nickell, Perraudin and Varotto (1998) look at the ratings transitions for types of obligor (see Table 3). Data on default probabilities over ten year horizons

10: Long-term foreign currency ratings.

11: The IMF has taken action to improve information released by governments. The Special Data Dissemination Standard will be strengthened to include more information on reserve assets and liabilities. Two further codes have been developed. A Code of Good Practices on Fiscal Transparency and a Code of Good Practices on Transparency in Monetary and Financial Policies.

Table 3: Conditional transition matrix

Banking

Terminal rating

Initial rating	AAA	AA	A	BBB	BB	B	CCC	C/CC	DEF	Number of issuer years
AAA	84.7	15.0	0.3	–	–	–	–	–	–	694
AA	0.4	87.8	11.5	0.3	–	–	–	–	–	1591
A	–	2.7	90.0	6.4	0.7	0.2	–	–	–	1826
BBB	–	0.9	16.4	75.1	5.8	1.8	–	–	–	434
BB	–	–	4.3	10.3	76.2	5.9	0.5	–	2.7	185
B	–	–	–	2.7	13.4	78.6	0.9	–	4.5	112
CCC	–	–	–	–	50.0	–	–	–	50.0	2
CC/C	–	–	–	–	–	–	–	–	–	0

Industrial

Terminal rating

Initial rating	AAA	AA	A	BBB	BB	B	CCC	C/CC	DEF	Number of issuer years
AAA	91.6	7.8	0.7	–	–	–	–	–	–	876
AA	1.1	89.3	9.1	0.3	0.2	0.0	–	–	–	2525
A	0.1	1.9	92.4	4.8	0.6	0.2	–	–	0.0	6728
BBB	0.0	0.1	3.9	89.9	4.9	0.8	0.1	–	0.2	5353
BB	0.0	0.1	0.4	3.4	87.0	7.4	0.2	0.0	1.5	5995
B	0.0	0.1	0.2	0.5	6.2	84.0	1.9	0.4	6.8	3751
CCC	–.	–	–	0.8	2.1	7.5	68.2	3.8	17.6	239
CC/C	–	–	–	–	1.4	6.8	20.5	56.2	15.1	73

Note: Data are notional unsecured Moody's long-term corporate and sovereign bond ratings between 31 December 1970 and 31 December 1997 measured on 31 December each year.

for US obligors, calculated from the data used in the study, indicate that banks in all ratings categories down to B are significantly less likely to default than non-banks. For AAA-rated obligors the default probabilities are 0.09 per cent for non-banks and 0.02 per cent for banks and for BBB-rated obligors the figures are 9.6 per cent for non-banks and 4.6 per cent for banks.

Nickell, Perraudin and Varotto find that the volatility of ratings changes is higher for banks than for industrials but large movements in ratings are just as likely if not more likely for industrials. When they focus on just US industrials and banks they find that, in a business cycle trough, highly-rated banks (AAA, AA and A) are more subject to downgrades than industrials. However, the opposite is true of banks rated BBB and below. These are more likely to experience an upgrade than would be the case for a corporate of the same rating. This may reflect the influence of regulation. Whereas all obligors face market pressure to deal with problems, banks also face pressure from regulators. As a bank became weaker, so some kind of regulatory action would become likely. For example in the United States, if a bank had many problem loans, and losses were likely, formal or informal action could be taken including discussions with management over the extent of any problems and following these the bank might be required to increase its provisions against future loan losses. A bank would not be able to pay dividends if that would leave it undercapitalised relative to the regulatory minimum after taking into account any need for higher provisions. This would make it more likely that the decline in the bank would be arrested or turned round.

Data on spreads on bonds issued by US banks, industrials and utilities with particular ratings, taken from Bloomberg, point to a rather different conclusion on the market's assessment of relative riskiness. For all ratings categories average spreads on bonds issued by banks were higher than spreads on industrial bonds or utilities (see Charts 1 and 2 above).

In part this will reflect the fact that many bank bond issues are subordinated. Because subordinated debt can count in Tier 2 capital under the Basel Accord, banks have an incentive to issue this kind of paper. The Bank of England has a large database of bonds put together from Reuters data and this shows a much higher use of subordination by banks than other types of obligor and a much lower use of guarantees for bank-issued bonds. Both factors would tend to imply higher spreads on bank bonds. In their study of US dollar denominated international bonds, Perraudin and Taylor (1999), however, find that bank spreads are slightly higher even when allowance is made for seniority. The spread difference is small (eg 6 basis points for AA), but it does appear to be statistically significant.

This may reflect perceptions about relative recovery rates. Altman and Kishore (1996), in a study of 700 US corporate bonds in default, find that financial institutions have lower recovery rates (36 per cent) than the average (42 per cent). The difference remains even after allowing for subordination. Recovery rates on subordinated debt issued by financial institutions, at 25 per cent, were significantly lower than the average, 31 per cent.

The evidence on whether exposures to banks are less risky than exposures to non-banks is therefore rather mixed. The evidence for the United States is that banks do have lower probabilities of default than non-banks and that in terms of ratings transitions, bank ratings are in a sense mean reverting: highly-rated banks are more likely to be downgraded and low-rated banks are more likely to be upgraded than industrials. The evidence from spreads is, however, that banks are regarded as somewhat more risky than industrials perhaps because of perceived recovery rates.

How well do credit risk models track credit portfolio risk?

A major development in recent years has been the introduction by practitioners of new techniques for measuring credit risk on portfolios of credit-sensitive exposures taking account of correlations between risks and therefore allowing for diversification effects. The most widely known of these models are ratings and equity value based models of J P Morgan (CreditMetrics) and KMV respectively and the more actuarial model – Creditrisk+ – advocated by Credit Suisse Financial Products (CSFP). These models have obvious weaknesses in that each contains parameters that affect the risk measures produced but which, because of a lack of suitable data, must be set on a judgmental basis. (For more discussion, see Jackson and Perraudin (1999) and Jackson, Nickell and Perraudin (1999).)

Up to now, few studies have systematically analysed credit-risk models from an empirical standpoint. Gordy (1999) compares the output from the CSFP model, Creditrisk+, and a simplified version of CreditMetrics in which obligors either default or do not, but no other ratings changes are considered. Using simulated data, Gordy shows that various risk measures may be obtained using either but that it is possible to parameterise the models so that the levels of these measures are broadly comparable. Crouhy, Galai and Mark (1999) compare four different credit-risk models on a benchmark portfolio of 1800 bonds diversified across 13 currencies and covering a wide range of countries, maturities and credit qualities. The VaR estimates they produce are roughly similar, the highest being 50 per cent larger than the lowest. They draw from this the perhaps questionable conclusion that credit-risk models are correctly measuring risk.

The only paper which so far has looked at credit-risk models on an out-of-sample basis, comparing risk measures with losses which would have been sustained on actual portfolios, is Nickell, Perraudin and Varotto (1998). They examine the degree to which two standard credit-risk models (one resembles CreditMetrics and the other a Merton-style model[12] like that of KMV) accurately estimate Value at Risk for portfolios of US dollar denominated international bonds over rolling twelve month periods between 1988 and 1998. Their study is somewhat negative in its conclusions since the models used in the study yield far more 'exceptions' than they would if they were accurately measuring risk.

While the models appear to perform adequately when used on exposures to US industrials, they underestimate the risks associated with exposures to non-US obligors and to banks and financials. Part of the problem is that many of the data inputs to such models are dominated by the experience of

12: See Merton (1974).

US industrials, which until recently comprised the vast majority of rated entities. When applied to credit exposures to a broader class of borrowers, Nickell, Perraudin and Varotto (1998) conclude that credit-risk models should be applied cautiously, adopting conservative parameterisations.

In summary, credit-risk models represent a substantial advance in the quantitative analysis of portfolios of credit exposures. Output from such models can help, for example, in identifying inadequate diversification, suggest hedging strategies and provide useful guidance for the allocation of economic capital. Questions remain, however, about the reliability of the risk measures they supply.

Are agency ratings reliable?

A substantial academic literature has examined which publicly observable variables (e.g. accounting ratios) affect ratings, whether stock and bond prices react to changes in ratings, and whether ratings are consistent with bond price yields and are useful in predicting financial distress. The general conclusions of the literature are that ratings can be reasonably well predicted using accounting information (see for example, Kaplan and Urwitz (1979)); that bond and equity values of an issuer move in the expected direction when the issuer's rating changes (see Hand, Holthausen, and Leftwich (1992)); and that ratings do help to predict financial distress and bond spreads (see Ang and Patel (1975) and Kao and Wu (1990)).

Recently, three papers have examined the usefulness of ratings as measures of default risk in a more critical light. First, Blume, Lim and MacKinlay (1998) conduct an analysis similar to that of Kaplan and Urwitz (1979) but lay stress in their conclusions on the finding that, between 1978 and 1995, firms with the same accounting ratios received a significantly lower rating in the mid 1990s than they did in the late 1970s and early 1980s. Second, Delianedis and Geske (1998) construct alternative indicators of credit risk for a large sample of US firms. Their approach employs equity and liability data and calculates probabilities of default using option-theoretic models. Their conclusion is that their equity-based default probabilities change well before ratings when firms fall into financial distress and that there is therefore evidence of 'rating stickiness' – where ratings agencies do not immediately change ratings when news affecting the credit quality of an obligor is revealed.

Third, Perraudin and Taylor (1999) examine how well bonds are priced using average spreads of the same or different ratings. To see whether ratings and bond spreads are consistent, they price the bonds in their sample using average spreads for three different ratings categories, AAA, AA, and A. If an AAA bond's actual price is less than the value calculated with AA or A spreads, the bond-market spreads are inconsistent with the rating. Similarly, if an AA-rated bond price is greater than that implied by AAA spreads or less than that implied by A spreads, or an A-rated bond has a price greater than that implied by AA spreads, then again the bond spreads and the ratings are not consistent. Perraudin and Taylor find that on average about a quarter of bonds are priced inconsistently with bond ratings and on occasion the fraction rises to a third of a particular rating category. It is not possible to say to what extent this reflects risk premia although their results are little changed when allowance is made for tax and liquidity effects.

Concerns have been raised in particular about agencies' treatment of sovereign borrowers (see IMF (1999)). Prior to the recent Asian crisis, emerging market sovereign ratings were extremely stable in comparison to those of similarly rated private sector obligors. The crisis provoked a sharp reduction in emerging market sovereign ratings, especially in Asia. To what extent the rating agencies deserve criticism for their sudden change of view on the credit standing of emerging-market borrowers is open to question, however, if only because bond market spreads just before the crisis struck also failed to foreshadow events.

Does the credit risk of bonds differ from that of loans?

So far, little is known about differences between the credit risk of relatively liquid exposures (bonds) and illiquid exposures (loans). Altman and Suggitt (1999) examine ratings transitions for US-syndicated loans and conclude that they behave very like bonds issued by similarly rated obligors. Their finding is not surprising, however, since the loan ratings are generally identical to those of bonds issued by the same companies; and in cases where Altman and Suggitt cannot obtain a rating for the loan, they actually infer it from the same obligor's bond rating.

An interesting study by Carey (1998) examines default histories of a large sample of US privately-placed bonds over the period 1986 to 1992, arguing that

such private placements resemble loans in that they are monitored quite actively by lenders as is bank debt. He finds that default rates are lower for private debt placements than for publicly issued debt especially in the sub-investment grade categories.

Finally, Carey (1994) examines the consistency of pricing in the bond and loan markets by comparing the new issue terms of loans with spreads on bonds issued by the same obligor. He finds that, adjusting for the fact that loans are generally floating rate whereas bonds are generally fixed-rate obligations, differences between bond and loan pricing are not larger than could plausibly be attributed to contractual features of the debt. Nevertheless, he stresses that the standard errors associated with his estimates are too large for confident statements to be made about loan and bond market consistency.

The evidence reviewed above suggests that the pricing of exposures and the probability of changes in credit standing are broadly similar in the bond and loan markets. However, there have been too few comparative studies of liquid and illiquid exposures for one to be confident of these conclusions and more research in this area is needed.

Conclusion

This article reviews the available evidence on the structure of credit risk – how the risk of exposures with a given rating varies across different types of borrower, different countries of domicile, and different maturities.

Research to date indicates that there is a strong maturity structure to credit risk, although some studies indicate that the positive dependence on maturity is less pronounced for lower quality credits. The evidence on the other questions is less clear cut. There is some evidence that the riskiness of exposures to borrowers with the same rating varies according to country of domicile but the effect does not appear to be particularly strong.

Likewise, there is no clear message on the differences between the riskiness of sovereign and corporate exposures. Ratings seem to be more stable for sovereigns than for industrials but data on bond-market spreads indicate that the market perceives exposures to BBB and BB sovereigns to be rather riskier than exposures to industrials, perhaps because dealing with problems is more complex and outcomes are less certain.

The evidence on banks versus industrials points to lowly-rated banks being less risky than lower-rated industrials, while the contrary is true for highly-rated banks and industrials. Overall, US evidence indicates that default probabilities are lower for banks than non-banks but the difference (around 50 per cent) is nowhere near the current difference in the capital requirements on the two groups (1.6 per cent for lending to banks and 8 per cent for lending to corporates). Also spreads indicate that the market perception is that exposures to banks are riskier than exposures to non-banks, perhaps reflecting higher loss given default rates.

In assessing relative credit risk on exposures to different types of obligor and across the maturity spectrum, this article has drawn on evidence from both market perceptions of risk (spreads) and more direct measures of credit risk (default rates and ratings changes). Given that most bank exposures are loans rather than bonds, more research is needed on the extent to which evidence from the bond markets can be used to draw conclusions about risk in loan books.

Empirical studies indicate that agency ratings are helpful in forecasting default. But, questions have recently been raised about: (i) the timeliness of ratings changes; (ii) the constancy of criteria used by the agencies in setting ratings; and (iii) apparent divergences between ratings and bond market spreads.

On the accuracy of credit risk models, although such models are clearly a major advance for banks and potentially for regulators in understanding banks' credit exposures, concerns remain about the reliability of the risk measures they supply. This is especially true in the case of non-US portfolios for which data are hard to obtain.

Finally, important avenues of research not examined in this paper include whether the structure of credit risk for large retail books and middle-market exposures is similar to that of large corporates and also the relationship between market liquidity and credit risk.

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