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CREDIT QUALITY SPREADS, BOND MARKET EFFICIENCY AND FINANCIAL FRAGILITY

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I INTRODUCTION

As shown in the chart below, the U.K. corporate-government bond yield spread rose strongly over the 1986–9 period. Some commentators saw it as a harbinger of recession, or sharp increases in corporate defaults, as were observed at previous peaks in the spread in 1974 and 1982. This paper seeks to address the underlying issue, namely the predictive power of U.K. domestic bond market spreads in relation to indicators of financial fragility. Do historic

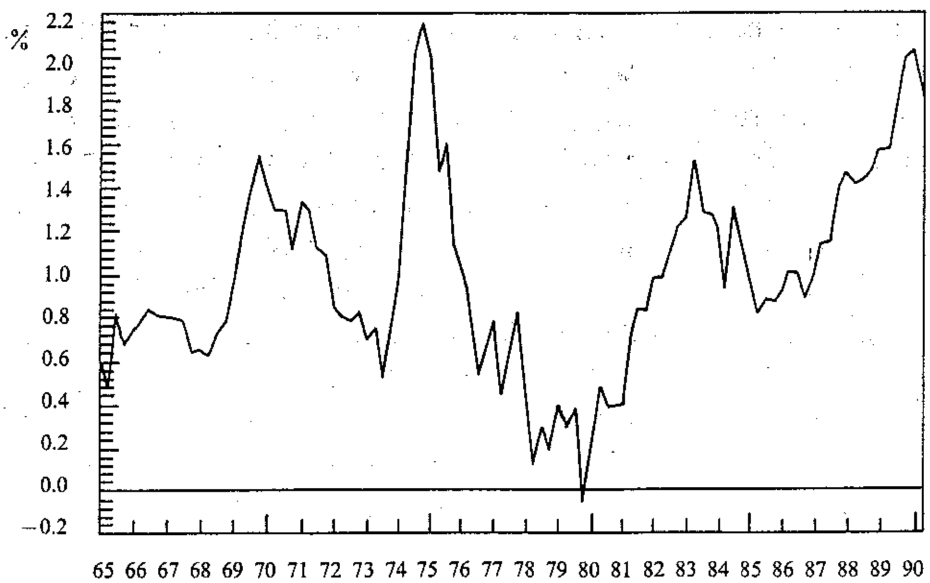

CHART 1 U.K. Corporate/Gilt Yield Spread

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patterns suggest that spreads are a sensitive indicator of the trade cycle and of corporate defaults, and hence that any implicit warning of fragility they give should be taken seriously? Such an analysis also casts light on the efficiency of the bond market in reflecting default risk, as well as the potential role of spreads as a monetary policy indicator.

The paper is organized as follows: Section II presents an outline of the theory of the determination of credit quality spreads in a "perfect market" setting where credit is rationed by price. Section III offers caveats to this analysis, based on the theory of quantity rationing, market segmentation and certain specific market imperfections in the U.K.. Section IV notes some extant empirical results regarding the determination of credit quality spreads and their usefulness as an indicator. Section V presents data for the U.K. and U.S. while Section VI shows results of various econometric tests of the U.K. spread, which are also reproduced for the U.S. and for subperiods to offer a comparison. Section VII provides a summary of results and the conclusions are presented in Section VIII.

II Theory of the Determination of Credit Quality Spreads

It is appropriate to begin with a few definitions. Debt must be held by another agent as an asset. Portfolio theory suggests that the return demanded by that agent will depend on the risk and the expected return on the asset. For example, an unsecured consumer loan will command a higher rate of interest than a Treasury bill of the same maturity owing to its relative risk characteristics. A consumer may default on interest and principal while the government can keep its promises *via* its power to tax and print money.[1]

These considerations may be formalized into a theory of the structure of interest rates (as summarized in Robinson and Wrightsman, 1980).[2] The spread between the yield on a private issue of debt and a risk-free public bond in the same national market depends on six factors: the risk of default, the call risk that bonds (or loans) may be liquidated early at a possibly inconvenient time for the lender; tax exemption status; the term or period to maturity; any screening costs; and market liquidity. In the current analysis, the major focus is on default risk. However, it is important to bear the other factors in mind because observed changes in spreads may arise from any of them.

Default risk refers to the possibility of not collecting coupon and principal as promised in the debt contract, even if a bond is collateralized.[3]

[1] Even government debt is not free of the risk of monetization *via* inflation and, for foreign holders, of the additional risk of exchange rate changes.

[2] The original analysis is in Fisher (1959).

[3] One may distinguish illiquidity risk—that the collateral may cover the value of the loan, but be hard to sell—and insolvency risk—that owing to changing relative prices the collateral no longer covers the value of the principal. Many of the recent worries concerning rising debt concentrate on this aspect.

The lender is likely to demand a higher expected return to compensate for the extra risk. An indicator of the market's assessment of default risk is the differential between the yield on a private bond and public bond of the same maturity, callability and tax features. It is important to distinguish the three returns concepts introduced here, namely the coupon, the expected return and the yield. The coupon may differ from the yield due to changes in the level of interest rates (or market expectations of associated capital gains and losses) from the time when the bond was issued. Such a deviation may occur for a public or a private bond. For a private bond, the yield will also differ from the expected return because the latter must be deflated to allow for expected default risk. For a given expected return, the yield must be higher to allow for a higher expectation of default risk. In practice, the lender would probably also demand a higher expected return in this case.

The overall default risk on a debt instrument varies with the risk position of the borrower and the economic environment. The risk position of the borrower is obviously conditioned by the ability to generate enough cash flow to cover interest and principal (the coverage ratio, or its inverse, income gearing), the variability of cash flow and the availability of liquidity or other assets to repay the debt. There may also be changes in the incentive to default, which may arise from changes in the bankruptcy law. A further factor may be "socialization" of risks. If it is assumed that the central bank or government will rescue certain debtors *via* bailouts (or monetization), the perceived risk of lending to them may decline.

Traditional theory suggests that for an individual agent default risk may be broken down into three elements. First, the risk position varies "internally" with balance sheet ratios such as the debt-to-equity ratio (there is no contractual obligation to pay equity holders). These ratios are choice variables arising from the budget constraint. Secondly, "business risk" is defined largely on the type of business the agent is in and is thus partly beyond his control. Thirdly, default risk for all firms depends on the state of the economic cycle and other macroeconomic variables such as interest rates and factor prices; most defaults occur during recessions. Note that the incidence of these macro variables on default risk is not independent of the firm's "internal" choices, e.g., the proportion of variable rate debt in the balance sheet.

Together these risks influence the probability of default by bond issuers.[4] To the extent that the market has based its expectations of future defaults on them, they will be reflected in the yield spread of corporate over government debt. The difference between market indices of yields (as opposed to yields on

[4] An alternative way of drawing similar results can be obtained from option pricing models (Merton, 1974) which stress the importance to bond returns of the value of the firm and the variance to its returns. The three factors outlined above are key influences on value and variance.

individual bonds) illustrates the weighted average expectation of default. It is differentials in such indices which are the main focus of the work in this paper.

As an example of magnitudes, the average differential between BAA and AAA bonds in the United States was about 50 basis points in the 1960s, 100 in the 1970s and 150 in the 1980s (see Chart 4). This may partly reflect changes in the perceived quality of the obligations.

Default risk premia are, of course, *ex ante* concepts reflecting the market's judgement of the probability of future defaults. Although it would be a cause for concern if risk pricing were totally inaccurate, it should not be a surprise if there are discrepancies between spreads and *ex post* bankruptcy experience, which reflect, obviously, a lack of perfect foresight.[5,6]

The above description of the determination of free market interest rates offers several insights into the relationship between spreads and stability. In particular, it indicates that, given the qualifications noted above, the market spread is a function of the *ex ante* probability of default of firms on average, which partly reflects developments in economy-wide conditions. Hence spreads may be useful predictors of financial fragility in the economy. However, there are some qualifications to this analysis which are discussed in the next section.

III Some Caveats

Quantity Rationing of Credit

In some credit markets, the price rationing paradigm outlined above may not apply because, due to information asymmetries between borrowers and lenders, interest rates offered to borrowers may be positively correlated with riskiness of loans (adverse selection leads to a reduction in the average quality of the mix of applicants, while incentives lead existing borrowers to undertake riskier actions—Stiglitz and Weiss, 1981). Some segmentation is necessary for the paradigm to apply, i.e., borrowers only have access to one type of credit.

Such a paradigm may be of particular relevance to households, where such rationing may be applied in terms of maximum loan-to-income ratios. It is also likely to be applicable to small firms which have no alternative to bank credit. Such rationing may distort the relationship between market spreads and defaults (although spreads are still likely to vary to some extent with default probabilities). It may also be pertinent to larger firms, even those with

[5]This is even more true for bond ratings, which have traditionally only been intended to measure the internal financial strength of the firm at the time of issue. Even at the time of issue, firms may find it costly to improve their rating, for example, because of the high liquidity demanded. More recently, the rating agencies have tended to shift to more continuous updating (see Dale and Thomas, 1990).

[6]It may also reflect more general excess volatility in asset prices (Shiller, 1981), which may in turn result from an influence of time-varying risk premia as well as new information on security prices.

bonds outstanding, during periods of financial fragility (firms which were seen as good risks, and hence price rationed in the upturn, may be quantity rationed during periods of financial fragility in some or all credit markets, notably *primary* bond markets).

However, it is less clear that such factors affect the main focus of this paper, namely *secondary* market spreads of outstanding corporate over government bonds. Even if a firm is quantity rationed in primary markets, yields on its outstanding bonds should continue to reflect market perceptions of default risk. And except in such situations, large firms will continue to be price rationed in primary as well as secondary bond markets.[7]

Market Segmentation

The validity of the description of price rationing in Section II depends on the potential for investors to substitute between instruments, e.g., out of corporate bonds into government bonds, which leads changes in expected economic conditions to be expressed in prices. However, if for any reason investors are unwilling to substitute, this effect may be attenuated. Moreover, if there is little substitution, supply of bonds in each market will have a heightened effect on the price (the arguments are analogous to the "preferred habitat" theory of the term structure), rather than being distributed over all markets, and this may further distort the economic indicator properties of the price or yield.

Market Imperfection: An Alternative View of the U.K. Market

The discussion in Section II assumes a functioning and well-informed market on the investor side. However, a counter-argument should also be considered. It has been suggested by Lund (1990) that certain adverse structural features in the U.K. bond markets distort credit spreads, especially at the long end, and this consequently reduces their utility as predictors of financial fragility. His main argument is as follows:

First, short-termism, with investors focusing on their own quarterly performance, may have led many investors to avoid U.K. corporate bonds. For example, since 1987 losses made due to rising corporate bond yields have led investors to fear investing on fundamentals, despite unrealistically high implied default rates on U.K. corporates. Such short-termism has not prevented spreads shifting upwards in response to concerns over potential LBOs ("event risk") and increases in supply but has distorted the absolute size of the spread. The high implied default rates are illustrated in Table 1.

[7]Note that secondary market prices may be influenced by primary market activity (for example, later issues of junk bonds may alter the default spread on existing bonds).

TABLE 1
SELECTION OF OUTSTANDING U.K. CORPORATE BONDS

Issuer	*Coupon*	*Maturity*	*Rating*	*Yield AIBD*	*Duration AIBD*	*Spread*	*Implied 10-Year Default Rate %*
ASDA	9·625	25/04/2002	NR	13·22	6·49	179	14·76
ICI	10·000	15/04/2003	AA−	12·46	6·77	113	9·64
MEPC	10·25	15/04/2003	A+	13·26	6·57	186	15·24
MEPC	9·875	15/04/2004	A+	13·32	6·78	200	16·31
ICI	9·750	15/05/2005	AA−	12·53	7·15	134	11·32
Hanson Trust	10·00	18/04/2006	AA*	12·79	7·19	162	13·50
John Lewis	10·250	06/05/2006	NR	12·55	7·28	141	11·87
Wellcome	9·750	19/05/2006	NR	12·62	7·36	152	12·69
Traf House	10·625	25/09/2006	NR	12·90	7·51	186	15·31
Land Secs	9·500	29/04/2007	A1	12·90	7·38	180	14·88
Slough Est	10·000	27/05/2007	A+*	13·29	7·27	215	17·42
Rank Org	10·625	11/07/2008	A+*	13·43	7·36	233	18·72
Pearson	10·500	13/06/2008	NR	13·21	7·37	211	17·14
Brit Airways	10·875	15/06/2008	NR	12·55	7·54	152	12·71
ASDA	10·875	20/04/2010	NR	13·06	7·39	197	16·08
Rank Org	10·625	09/08/2010	A+	13·36	7·61	236	18·96
John Mowlem	11·500	27/05/2013	BBB+*	12·96	7·65	197	16·10
Blue Circle	10·750	29/11/2013	A3	12·74	8·32	201	16·45
Hammerson	10·750	07/12/2013	A1	13·02	8·22	225	18·21
John Lewis	10·500	23/01/2014	NR	12·54	8·58	191	15·70
P & O Steam	11·500	03/07/2014	A1	13·01	7·78	206	16·84
Trafalgar	10·875	30/09/2014	NR	12·99	8·08	217	17·61
Brit Aerospace	10·750	24/11/2014	NR	12·81	8·32	208	16·98
Tesco	10·500	22/11/2015	AA3	12·57	8·49	190	15·64
ABP	10·875	16/12/2015	NR	12·80	8·41	211	17·18
Granada	11·250	11/01/2019	A*	13·07	8·42	238	19·13
Lucas	10·875	10/07/2020	NR	13·17	7·93	228	18·45

* IBCA rating.
Source: Credit Suisse First Boston.

Meanwhile, long-term investors, who could profit from such a situation, appear to have stayed away.[8]

Lund's explanation for this is lack of available research into credit issues and lack of training of bond managers in credit analysis, as opposed to macroeconomic issues.[9] The relatively low volume of U.K. domestic corporate bonds outstanding, until recently, may have led firms to consider that the costs of such analysis exceed the benefits. On the borrower side, too, a range of borrowers may have dismantled the infrastructure required for issuance. Finally, the recent increase in new issues has, in the presence of these imperfections, driven up spreads and no forces are acting to reduce them.

[8]Such a situation suggests that adaptive rather than rational expectations hold in this credit market.

[9]The absence of credit ratings may also have had a role to play.

The principal focus of Lund's research is rather short term, i.e., in explaining the increase in corporate bond yields relative to government bonds since 1987. However, given the relative lack of issues in U.K. sterling bond markets since the 1970s, it is also plausible that inefficiencies related to lack of credit research may be longer standing. A counter-argument is, of course, the relative buoyancy of issuance in the Eurosterling market in the 1980s and the more recent recovery in domestic issuance (see Pratt and Simpson, 1988). We assess these inefficiency hypotheses by tests on various subsamples in the econometric tests below (while noting that the data may be unable to distinguish effects of liquidity, segmentation and other adverse structural features).

We now go on to assess the evidence relating to credit quality spreads. First, a review is made of recent contributions to the literature before a more searching analysis is made of behaviour in the U.K. and U.S..

IV Extant Empirical Work

The Determination of Spreads and their Relationship to Default

Much of the literature on defaults and spreads has used U.S. data. These studies offer a number of conclusions which confirm aspects of the theory outlined in Section II. First, coverage, earnings variability and other measures of capital structure have been shown empirically to influence differences in market default risk premia between firms (see Hickman, 1958). In the case of bonds, these risk elements may be assessed by bond rating agencies; for loans, it is the responsibility of the bank or other financial institution. Second, average default risk premia also vary over the cycle; the premium widens during recessions for all firms, but especially for lower-rated bonds which are more vulnerable to default (see Jaffee, 1975), as well as for smaller firms with high leverage.[10] Third, prediction of bankruptcy by observed spreads, although consistent, is rather inaccurate. For example, Fons (1986) suggested that risk was being overpriced[11] in U.S. corporate bonds in the 1980s, although the risk premium did track the sign of the change in defaults.

Wadhwani (1986) investigated effects of inflation on liquidation rates and default premia in the U.K. bond markets. Wadhwani's results showed that price inflation had a significant effect on bankruptcy and default premia, independent of real interest rates, though he found the structure of default premia and bankruptcy equations rather different (as noted above, market perceptions *ex ante* may not be good predictors of *ex post* bankruptcies; also,

[10] A paradox is that spreads tend to vary more than *ex post* default risk. Some have explained this by time-varying risk preferences, where risk premia depend on the covariance of the return on the asset with the marginal utility of consumption (Breedon, 1979).

[11] This may be due to risk aversion on the part of investors.

there are other influences on the spread besides default risk and the implicit assumption of risk neutrality may not be correct).

Using similar regressions to Wadhwani, Davis (1987) tested the time series properties of spreads and defaults. Estimates of pooled time series/ cross-section equations for defaults and spreads in the major countries gave similar significant variables on the right-hand side.

Indicator Properties

Following the reasoning outlined in Section II, which showed the importance of general economic conditions in determination of the spread, a number of authors have assessed the predictive power of corporate-government spreads in a more general macroeconomic sense. For example, Bernanke (1983) showed that the corporate (BAA)-Treasury bond spread in the U.S. accurately forecast industrial production in the inter-war period. Friedman and Kuttner (1989) concluded that the commercial paper-Treasury bill spread had strong predictive power for industrial production over recent decades. Finally, Keim and Stambaugh (1986) found monthly risk premia on bonds could be predicted by the spread between BAA corporate bonds and Treasury bills. The latter spread also had predictive power for equity market prices. Obviously one interpretation of these results is that private-public spreads measure expected default risk, as discussed above, which rises during recessions. Alternatively, an increase in the spread might, *ceteris paribus*, reduce incentives to invest, resulting in a decline in aggregate demand.

Stock and Watson (1990), sought to revise the indices of leading and coincident indicators of the U.S. economy (devised originally by Burns *et al.*, 1946). By this means, they hoped to provide a formal probability model within which appropriate variables could be selected and combined. They produced experimental indices of coincident and leading economic indicators and of recession. The coincident index was tested by tracking of an unobserved index of the state of the economy and not real GNP itself—though "growth (of the index) was highly correlated with growth of real GNP"; the leading index was designed to accurately forecast the coincident index, the recession indicator to forecast declines in it.

The construction of the coincident indicator is basically by means of a dynamic factor model estimated by use of Kalman Filters, wherein it is assumed that co-movements of multiple time series arise from a single source, the unobserved state of the economy. However, the interest in this context is more in terms of the leading index. This is constructed by modelling the leading variables and the cyclical series (in this case the unobserved state of the economy) by means of a vector autoregressive system:

$$\Delta C = Mc + \lambda cc(L)\Delta C_{t-i} + \lambda cy(L) Y_{t-i} + V_{ct} \qquad (1)$$

$$Yt = My + \lambda yc(L)\Delta C_{t-i} + \lambda yy(L) Y_{t-i} + V_{yt} \qquad (2)$$

where C is the series to be predicted, Y the leading variables (transformed to be stationary), (V_{ct}, V_{yt}) serially uncorrelated errors and the orders of the lag polynomials were determined empirically.

Within this framework, the leading economic indicators chosen were: the yield curve (long-short-term Treasury bond yield spread); the *private-public interest rate spread* (although this was at short maturities, i.e., 3-month Commercial bills less 3-month Treasury bills); changes in the 10-year Treasury bond yield; the trade-weighted nominal exchange rate; part-time work in the non-farm sector; housing authorizations; and manufacturers' unfilled orders.

V A Closer Examination of U.K. and U.S. Data

Charts 2 and 3 show patterns for the U.K. from 1968–89 of spreads and associated variables. Corresponding "control" data for the U.S. are assessed in Charts 4 and 5. The U.K. spread employed is the 20 to 25-year debenture yield less the 20-year gilt yield.[12] Long runs of data are not available for shorter maturities. The yield series are gross redemption yields for a basket of bonds for the given maturity. No breakdown by credit quality is available—Table 1 shows a typical cross-section.

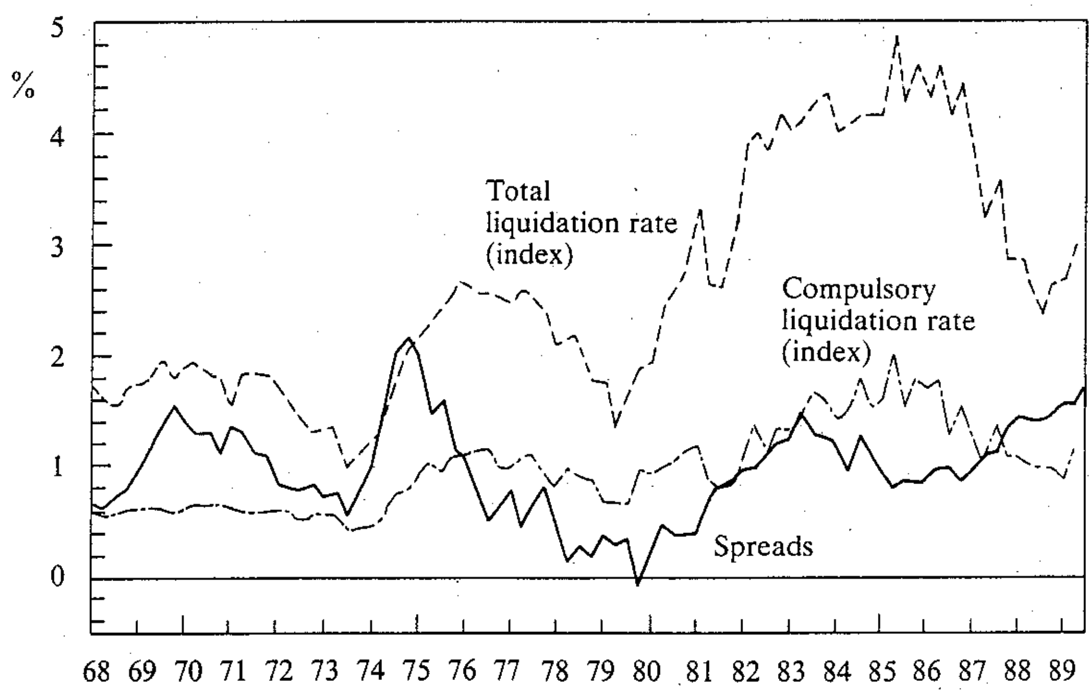

Chart 2 U.K. Spreads and Liquidations

[12]Note that we use an absolute spread and not a ratio of one yield to another. This is justified by the fact that risk premia are set in terms of absolute amounts.

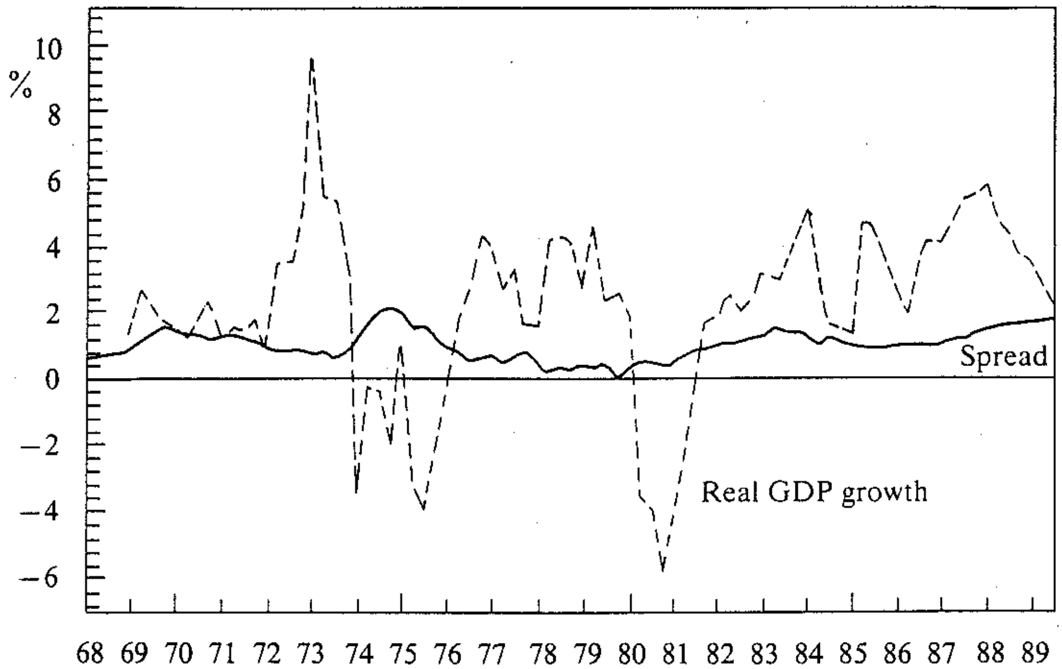

CHART 3 U.K. Spreads and the Cycle

Chart 2 shows spreads and corporate liquidation rates—both compulsory and total (i.e., including creditors' voluntary liquidations). Obviously, this includes a large proportion of small firms not active in bond markets. The spread series shows marked peaks in 1969, 1974, 1982–3 and

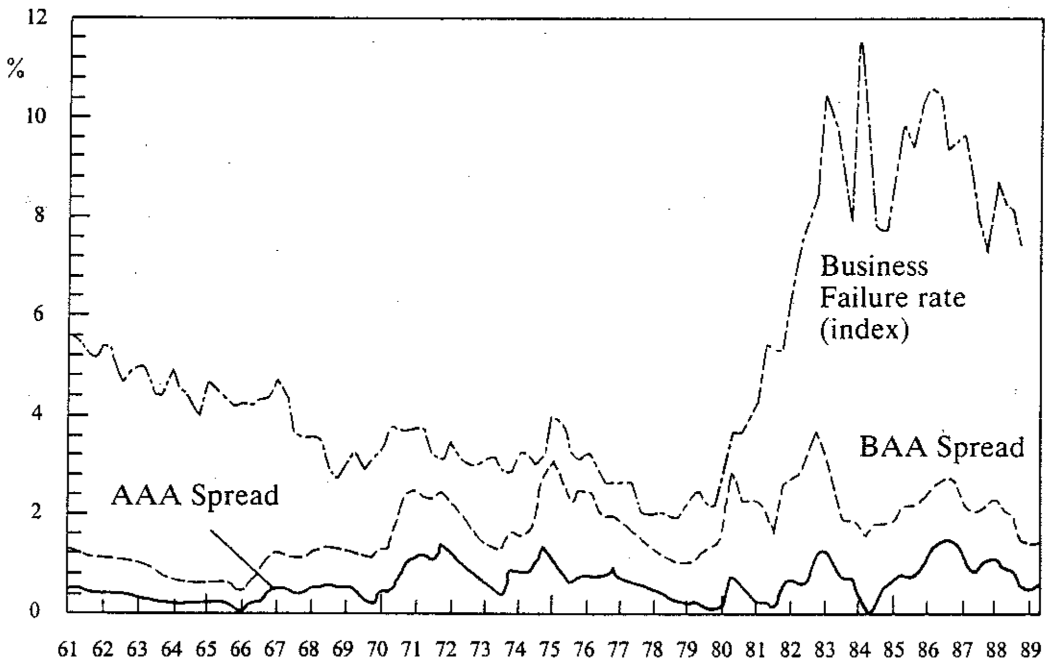

CHART 4 U.S. Spreads and Liquidations

1989, the troughs being in 1968, 1973, 1978–9 and 1985. Liquidations show broadly similar patterns, although the level tends to remain at the peak levels for much longer. Hence *total* liquidations were "high" relative to previous experience in 1969–71, 1974–7 and 1982–5. Troughs in this series are found in 1973, 1979 and 1988. Compulsory liquidations are broadly similar, although the variation in the series is much less marked. Economic patterns of liquidation have, of course, been overlaid by legal changes, notably the Insolvency Act of 1987.

Chart 3 shows spreads alongside the economic cycle. Theory suggests spreads should rise when recessions are anticipated in order to reflect heightened default risk. In cycles up to the early 1980s, this appears broadly to be the case. Thus spreads fell during the boom of 1972–3 before rising in the recession of 1974. They then declined again in the late 1970s before increasing again in the slump of the early 1980s. However, they then continued to rise for much of the recovery of 1982–4, fell in 1984–6—a period of uneven albeit positive growth—and rose again in 1986–9. A question posed in Section III above is whether the current increase is due to market imperfections and other special factors, or is signalling a sharp recession.

For comparison with the U.K., Charts 4 and 5 show similar series for the U.S.. Chart 4 illustrates the relationship between spreads (BAA corporate less 10-year Treasuries) and liquidations. It should be noted that the U.S. data definitions were changed in 1984 and the Bankruptcy Act of 1978 may have increased the incentive to go bankrupt. These changes aside, it is evident that

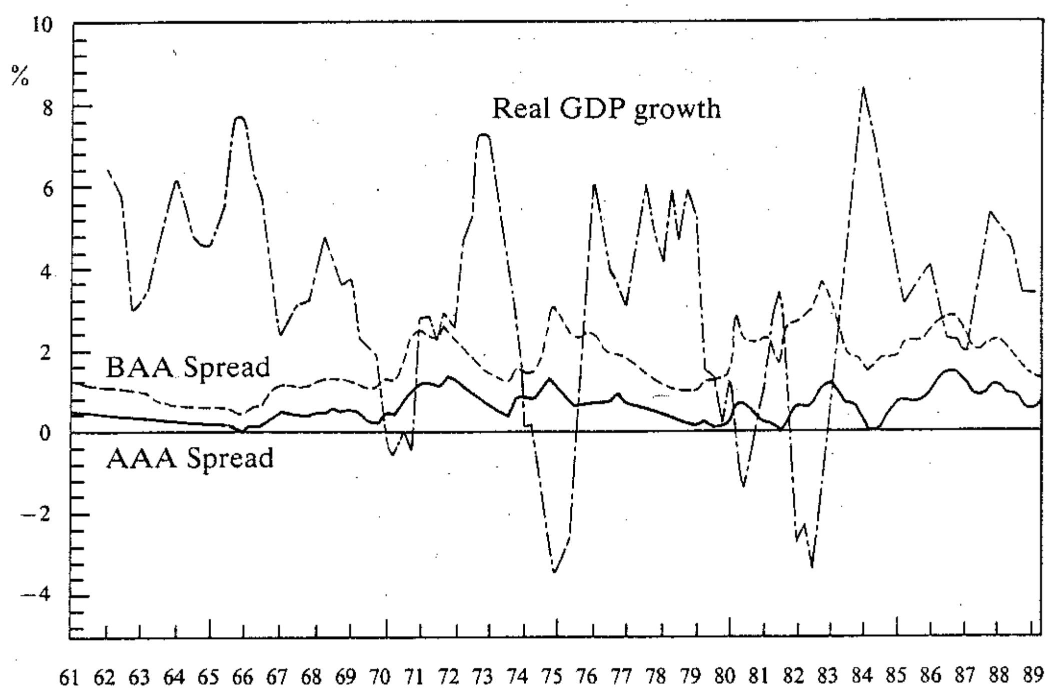

CHART 5 U.S. Spreads and the Cycle

the spreads-liquidations relationship is close. Almost every rise or fall in the liquidation rate is reflected in spreads.

Chart 5 shows the spreads-real GDP relation. The relation appears less close than for liquidation (as might be expected, since GDP is only an indicator of potential defaults). Nevertheless, it is evident that spreads do rise during and after major downturns such as 1969–70, 1973–74, 1979–80 and 1981–2 and generally fall during periods of rapid GDP growth.

VI Econometric Tests

We carried out econometric tests in order to assess the usefulness of spreads in the U.K. context. As a "control" we estimated similar equations for the U.S. (where one would expect bond market efficiency *a priori*). In effect, successful results for the U.S. can be taken to show that any problems for the U.K. result from market imperfections rather than misspecification. We also split the U.K. sample, to assess whether efficiency has declined over time (as suggested in Section III).

The tests are in five parts; first, we tested the indicator properties of spreads in *predicting* defaults, real GDP and industrial production in the context of simple time series models. Then we estimated equations for corporate defaults along lines similar to Wadhwani (1986) to assess whether spreads significantly improve the predictions of the defaults equation. We also tested whether spreads enable one sensitively to predict the variables that influence bankruptcy. Fourth, we estimated a (backward-looking) equation for determination of spreads, thus enabling tests to be carried out for an influence of issuance on spreads (as per the market segmentation hypothesis). Such an exercise (together with the defaults equation) also enables one to assess coincident behaviour of spreads and defaults, i.e., whether spreads *reflect* default risk. This was done by assessing whether defaults and spreads are determined similarly in the cointegrating vectors.

A summary of the results is provided in Section VII.

Time Series Regressions: Do Spreads Help Predict Activity and Defaults?

Following the approach of Stock and Watson noted in Section IV, we estimated simple autoregressions in the difference of activity and the liquidation rate, then tested in a VAR framework whether differences of spreads could add information to such autoregressions (i.e., Granger-causality) and whether there is any reverse causality. The approach was to assess prediction of the difference of the log of activity[13] and the default rate

[13]Thus, unlike Stock and Watson, we do not construct a separate series summarizing the "state of the economy" but assess direct prediction of national income itself.

over the next quarter by lags of changes of spreads, i.e.:

$$\Delta_1 \ln\begin{pmatrix}\text{default rate}\\ \text{activity}\end{pmatrix} = C_1 + \sum_{i=1}^{4} \lambda_{11}\Delta_1 \ln\begin{pmatrix}\text{default rate}\\ \text{activity}\end{pmatrix} t-i + \sum_{i=1} \lambda_{12}\Delta_1 \text{spreads}_{t-i} \tag{3}$$

$$\Delta_1 \text{spreads} = C_2 + \sum_{i=1}^{4} \lambda_{21}\Delta_1 \text{spreads}_{t-i} + \sum_{i=1}^{4} \lambda_{22}\Delta_1 \ln\begin{pmatrix}\text{default rate}\\ \text{activity}\end{pmatrix} t-i \tag{4}$$

Spreads were the 25-year corporate bond yield-20-year gilt yield (for the U.K.) and the BAA corporate-10-year Treasuries (for the U.S.). In each case, default rates were defined as the log of business failures as a proportion of the numbers of active companies.[14] Two activity variables were used, real GDP and industrial production. The latter variable (excluding energy and water for the U.K.) enables one to check that U.K. results are not distorted by the advent of North Sea oil. It also facilitates a transition to monthly data.

TABLE 2
VECTOR AUTOREGRESSION TESTS: GENERAL EQUATIONS

Independent/Dependent Variable		*U.K. 1968–1989*	*U.K. 1962–1988*	*U.S. 1968–1977*	*U.K. 1978–1989*
Spreads/	*F*	1·88	3·4	1·4	1·0
Bankruptcy	*t*	0	1	0	0
Spreads/	*F*	1·78	2·34	3·2	1·53
GDP	*r*	0	1	1	0
Spreads/	*F*	1·09	2·08	2·5	1·32
Industrial production	*f*	0	0	1	0
Bankruptcy/	*F*	1·89	0·38	1·38	0·54
Spreads	*t*	0	0	0	0
GDP/	*F*	1·0	2·22	0·96	0·48
Spreads	*t*	0	1	0	0
Industrial production/	*F*	0·71	1·01	0·79	0·93
Spreads	*t*	0	0	0	0
Critical F-value		2·53 (4,60)	2·45 (4,120)	2·69 (4,30)	2·69 (4,30)

Structure: the first difference regressed on first to fourth lags of first difference. Therefore *F* is for 4 restrictions jointly and *t* is for number of significant *t*-values on independent variables in the general equation.

Results are shown in Tables 2 and 3. Focusing first on the results for the complete U.K. sample, in no case were the four lags of the independent variable jointly significant in a VAR equation—and there were also no *t*-values over 2. For the U.S., in contrast, the *F*-tests suggest that spreads

[14]Note that this measure includes many small firms which are not active in bond markets.

TABLE 3
VECTOR AUTOREGRESSION TESTS: RESTRICTED EQUATIONS (SIGNIFICANT COEFFICIENTS AND t-VALUES)

Independent/ Dependent Variable	*U.K. 1968–1989*	*U.S. 1962–1988*	*U.K. 1968–1977*	*U.K. 1978–1989*
Spreads/ Bankruptcy	—	$0{\cdot}10\Delta S_{-1}$ (3·6)	$0{\cdot}168\Delta S_{-1}$ (2·1)	—
Spreads/ GDP	$-0{\cdot}015\Delta S_{t-4}$ (2·4)	$-0{\cdot}0093\Delta S_{t-1}$ (2·8)	$-0{\cdot}022\Delta S_{t-4}$ (2·3)	$0{\cdot}0203\Delta S_{t-3}$ (2·4)
Spreads/ Industrial production	$-0{\cdot}021\Delta S_{t-1}$ (1·9)	$-0{\cdot}017\Delta S_{t-1}$ (2·0)	$-0{\cdot}05\Delta S_{t-3}$ (2·9)	$0{\cdot}029\Delta S_{t-3}$ (1·9)
Bankruptcy/ Spreads	$-0{\cdot}429\Delta B_{t-3}$ (2·0)	—	$-0{\cdot}846\Delta B_{t-3}$ (2·0)	—
GDP/ Spreads	—	$-9{\cdot}23\Delta Y_{t-2}$ (2·5)	—	—
Industrial production/Spreads	—	—	—	—

S = spreads.
B = log of bankruptcy ratio.
Y = log of real GDP.

Granger-cause default even in the general VAR framework and there were significant t-values in all but the inverse (defaults-spreads) equation. Restricting the lags to those which were most significant yielded positive results for the U.K. too. They suggest that spreads Granger-cause GDP at the fourth lag and industrial production at the first lag. Paradoxically, there was also a *negative* inverse relationship between bankruptcies and spreads. For the U.S., the expected relationship was found between spreads and defaults at the first lag. There was no inverse relationship. In common with Stock and Watson, we also found that spreads Granger-cause GDP and industrial production at the first lag. There was also an inverse relationship for GDP.

The U.K. sample was divided at the end of 1977 to test for effects of the moribund corporate bond market in the later period on Granger-causality. For the earlier period, when the market was active, both bankruptcies and the cycle were Granger-caused by spreads with the expected signs. The results were similar to those in the U.S., suggesting that the U.K. corporate bond market efficiently predicted adverse economic developments over this period. The inverse relation between bankruptcies and spreads remained significantly negative. In contrast, for the later period only the spreads-activity relations showed significant Granger-causality and, in this case, spreads were *positively* related to real GDP and industrial production. This may imply that expectations of economic growth and associated issuance are now the major determinants of spreads, in line with the market segmentation hypothesis.

The Role of Spreads in a Corporate Default Function

We assessed determinants of defaults using the Wadhwani (1986) reduced-

TABLE 4
TIME SERIES PROPERTIES OF THE VARIABLES

		Level		*Difference*	
	Mnemonic	*DF*	*ADF*	*DF*	*ADF*
UNITED KINGDOM					
Corporate debt/GDP ratio (log)	D/Y	−0·7	−0·8	−8·4	−6·0
Real GDP (log)	GDP	0·6	0·6	−8·8	−5·5
Real wages (log)	RW	−0·7	−0·1	−16·5	−11·6
Real raw materials prices (log)	RM	−1·8	−1·7	−8·1	−5·0
Short rate % (base rate) (level)	R	−2·1	−2·5	−7·1	−4·4
Spread % (level)	YS	−1·9	−2·1	−6·0	−4·5
Liquidation ratio (log)	PCL	−1·3	−1·4	−8·4	−5·0
Births ratio (log)	PB	−2·2	−2·1	−10·4	−7·1
Real interest rate % (level)	RR	−1·3	−2·1	−6·0	−4·5
UNITED STATES					
Corporate debt/GDP ratio (log)	D/Y	0·3	−0·2	−8·7	−4·5
Real GDP (log)	GDP	−0·4	−0·4	−7·4	−4·9
Real wages (log)	RW	−1·5	−1·7	−5·7	−3·6
Real raw materials prices (log)	RM	−1·4	−1·8	−7·7	−5·3
Short rate % (level)	R	−2·1	−2·4	−8·3	−7·4
Spread % (level)	YS	−3·0	−3·6	−8·3	−7·4
Liquidation ratio (log)	PCL	−0·8	−1·0	−9·0	−8·7
Births ratio (log)	PB	−1·7	−1·8	−8·0	−8·8
Real interest rate % (level)	RR	−1·8	−2·0	−8·7	−7·6
Critical value ≃ −3·2					

form model of corporate default[15] as a testbed for further examination of the predictive power of spreads. Independent variables in the default function included the corporate debt-GDP ratio, real GDP and the real and nominal short-term interest rate, as illustrated in the charts in Section V. To these were added real wages and real raw materials prices as additional factors underlying corporate profitability and births of firms to allow for the firm life-cycle process. The equations were estimated by the Granger-Engle two-step method, where results are first assessed for a long-run cointegrating vector before insertion of its residuals into a short-run dynamic framework.

It is essential, first, to check the time series properties of the variables—the results are shown in Table 4. They show that all the variables both for the U.K. and U.S. are $I(1)$. This is surprising for some of the variables (inflation, interest rates, liquidation ratios, debt ratios) and is probably related to the small size of the sample (quarterly 1968:2–1989:2 for the U.K., quarterly 1961:1–1988:4 for the U.S.).

[15] His approach is to model the behaviour of a firm and then test the resulting specification using macroeconomic data. Thus, his model combines the objective function of a firm, a borrowing constraint and a budget constraint to derive a model in which bankruptcy depends on factor prices, real and nominal interest rates, corporate gearing, aggregate demand and the price level. Given the link of returns on corporate bonds to corporate default, credit quality spreads are shown to depend on similar variables.

TABLE 5
BANKRUPTCY EQUATION: COINTEGRATING VECTOR

	U.K. *1968–1989*	*U.S.* *1961–1988*	*U.K.* *1968–1977*	*U.K.* *1978–1989*
Constant	−29·0	−1·8	47·1	13·2
	(5·2)	(1·6)	(2·5)	(1·5)
Log birth ratio	−0·92	0·65	0·06	0·51
	(7·2)	(3·5)	(0·3)	(1·7)
Log debt/GDP	−1·75	3·93	−2·5	1·11
	(7·4)	(6·2)	(8·7)	(1·6)
Log real GDP	−1·45	—	−5·4	−5·4
	(2·2)		(3·6)	(6·4)
Log real wages	6·3	−5·17	1·92	5·95
	(11·9)	(6·9)	(2·3)	(9·0)
Log real raw materials price	0·81	1·3	1·57	0·72
	(3·3)	(3·3)	(3·3)	(2·3)
Real short rate	0·012	0·078	−0·083	0·001
	(2·4)	(8·0)	(1·4)	(0·8)
Nominal short rate	−0·06	−0·067	−0·027	−0·015
	(6·3)	(4·8)	(1·3)	(1·4)
Dummy for U.S. Bankruptcy Act		3·9		
		(3·5)		
Dummy for U.S. data change		0·56		
		(4·5)		
Dummy for U.K. Insolvency Act	−0·27			−0·4
	(2·3)			(4·6)
Dummy for U.K. strike	−0·39			−0·26
	(3·5)			(2·9)
$\bar{R}^2$	0·83	0·83	0·83	0·89
SE	0·17	0·19	0·11	0·11
DF	−4·7	−3·3	−4·3	−4·5
ADF	−3·7	−3·7	−3·3	−3·5
CRDW	0·9	0·4	1·4	1·3

The cointegrating vectors for the full samples are shown in the first two columns of Table 5. The Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) statistics are generally satisfactory, though the Cointegrating Regression Durbin-Watsons (CRDW) are rather high. The U.K. defaults vector has expected (significant) signs for real wages, real raw materials prices, real interest rates and real GDP. A high birth ratio reduces the number of defaults. The debt income ratio[16] and nominal interest rates do not have expected signs, both tending to reduce liquidations. For the U.S. debt-income ratios, real raw materials prices, real GDP and real interest rates have correct (significant) signs while real wages and nominal short rates have negative signs.[17] Births in the U.S. are positively correlated with defaults, suggesting a high turnover of new small firms during an upturn.

[16]However, if one drops the debt ratio, the equation does not cointegrate.

[17]The result for real wages may relate to the lack of real wage growth over the last decade, while bankruptcies have increased sharply. It may also reflect a more flexible labour market where real wages fall in a recession.

Using these long-run vectors, we conducted tests to assess further the relationship between spreads and defaults. If the level of spreads enters the long-run cointegrating vector for liquidations, this would imply a stable long-run relationship between spreads and defaults, suggesting consistent pricing of risk. In fact, as shown in Table 7, for the U.K., although they had the correct (positive) sign they were insignificant when added to the vector shown in Table 5 ($t = 1{\cdot}1$). In contrast, spreads were strongly significant in the U.S. cointegrating vector ($t = 5{\cdot}8$).

We proceeded to the second stage of the Granger-Engle procedure, testing for dynamics in an equation for the difference of the dependent variable where the residuals of the cointegrating vector enter as an independent variable. We tested down from a general equation with four lags of the difference of the dependent variable, the level and four lags of differenced independent variables, and the cointegrating vector residual entered at the first lag. Four observations were retained for forecasting.

Results are shown in Table 6. For the U.K., the growth of GDP has a negative impact while nominal rates have a positive effect, perhaps reflecting cash flow constraints as stressed by Wadhwani, as well as monetary tightening. In contrast, real interest rates had a negative effect in the short term (i.e., rising inflation has a positive effect). For the U.S., increased births and declining GDP accompany defaults in the short term.[18] The U.S. cointegrating vector was significant, while the U.K. vector only had a t-value of 1·7. The short-term equations pass all the diagnostic tests.

Within this framework, one can test the short-run relation of spreads to defaults by entering differences of spreads in the dynamic equation for defaults. These tests seek to offer further insight into the predictive power of spreads. Again, we first entered the level and four lags of spreads before testing down. As shown in Table 7, spreads were insignificant for the U.K., although the sign is correct. For the U.S., the spread was significant at 90 per cent ($t = 1{\cdot}9$), complementing the significant levels effect. Taken together, the results in Table 7 imply a greater predictive power for spreads over bankruptcies in the U.S. than the U.K..

Again we split the U.K. sample at end-1977 to assess whether any change in behaviour could be discerned. We imposed the same specifications as for the entire sample.[19] (The short periods used imply caution is required in assessing the results.) Looking first at the cointegrating vector, the real interest rate effect detectable in the whole sample is not apparent in either subperiod. A notable contrast between subperiods concerns the sign changes on the debt ratio, which relates negatively to defaults in the earlier period and *vice versa* in the later period. The dynamic equations display considerably more similarity between subperiods.

[18]The lack of a nominal interest rate effect may relate to the greater preponderance of fixed rate debt.

[19]Lack of observations prevented a full general-to-specific testing exercise.

TABLE 6
BANKRUPTCY EQUATION: DYNAMIC EQUATIONS
(For Mnemonics, see Table 4)

U.K.: 1969–1988

$$\Delta_1 \ln PCL_t = \underset{(2\cdot7)}{0\cdot28\Delta_1 \ln PCL_{t-3}} - \underset{(2\cdot4)}{1\cdot9\Delta_1 \ln GDP_{t-2}} + \underset{(2\cdot5)}{0\cdot027\Delta_1 R_{t-1}} - \underset{(3\cdot6)}{0\cdot023\Delta_1 RR_{t-1}} - \underset{(3\cdot7)}{0\cdot25\Delta_1 DUMS} - \underset{(1\cdot7)}{0\cdot12RES_{t-1}}$$

$\bar{R}^2 = 0\cdot34$, SE = 0·09, DW = 2·3, Forecast(4) = 2·7, LM(4) = 4·5, BJ(2) = 0·1, ARCH(1) = 0·6, RESET(3) = 1·9

U.S.: 1962–1987

$$\Delta_1 \ln PCL_t = \underset{(2\cdot3)}{0\cdot19\Delta_1 \ln PCL_{t-2}} - \underset{(2\cdot0)}{2\cdot1\Delta_1 \ln PB_t} - \underset{(5\cdot1)}{3\cdot6\Delta_1 \ln GDP_t} + \underset{(5\cdot2)}{0\cdot4\Delta_1 DUM84} - \underset{(2\cdot0)}{0\cdot076RES_{t-1}} + \text{seasonals}$$

$\bar{R}^2 = 0\cdot62$, SE = 0·07, DW = 1·6, Forecast(4) = 2·9, LM(4) = 5·7, BJ(2) = 3·1, ARCH(1) = 0·1, RESET(3) = 3·8

U.K.: 1969–1976

$$\Delta_1 \ln PCL_t = \underset{(1\cdot4)}{0\cdot2\Delta_1 \ln PCL_{t-3}} - \underset{(1\cdot8)}{2\cdot1\Delta_1 \ln GDP_{t-2}} + \underset{(1\cdot7)}{0\cdot029\Delta_1 R_{t-1}} - \underset{(3\cdot2)}{0\cdot021\Delta_1 RR_{t-1}} - \underset{(2\cdot2)}{0\cdot37RES_{t-1}}$$

$\bar{R}^2 = 0\cdot41$, SE = 0·08, DW = 1·8, Forecast(4) = 1·2, LM(4) = 1·1, BJ(2) = 0·3, ARCH(1) = 0·04, RESET(3) = 1·4

U.K.: 1979–1987

$$\Delta_1 \ln PCL_t = \underset{(2\cdot0)}{0\cdot3\Delta_1 \ln PCL_{t-3}} - \underset{(0\cdot8)}{1\cdot1\Delta_1 \ln GDP_{t-2}} + \underset{(1\cdot4)}{0\cdot029\Delta_1 R_{t-1}} - \underset{(2\cdot1)}{0\cdot023\Delta_1 RR_{t-1}} - \underset{(3\cdot1)}{0\cdot25\Delta_1 DUMS} - \underset{(2\cdot1)}{0\cdot36RES_{t-1}}$$

$\bar{R}^2 = 0\cdot2$, SE = 0·16, DW = 1·8, Forecast(4) = 1·8, LM(4) = 5·1, BJ(2) = 0·1, ARCH(1) = 0·3, RESET(3) = 2·6

TABLE 7
SPREADS IN BANKRUPTCY EQUATION (COEFFICIENT AND *t*-VALUE)

	U.K. 1968–1989	*U.S. 1961–1988*	*U.K. 1968–1977*	*U.K. 1978–1989*
Level in cointegrating vector	0·09 (1·1)	0·21 (5·8)	0·18 (2·5)	−0·02 (2·3)
Differences in dynamic estimate	$0\cdot06\Delta YS_{t-1}$ (1·1)	$0\cdot04\Delta_1 YS_{t-4}$ (1·9)	$0\cdot14\Delta YS_{t-1}$ (2·1)	$-0\cdot01\Delta YS_{t-1}$ (0·1)

The defaults equations were again used to test for effects of levels and differences of spreads (Table 7). In the earlier period, both were significant with a positive sign, as in the U.S., suggesting a market efficiently reflecting and predicting default risk. In the later period, the difference was insignificant and the level significantly *negative* (i.e., spreads have fallen during periods when defaults have increased). Again this may be consistent with a positive relationship with issuance (during periods of low default and high GDP growth).

The Predictive Power of Spreads for Leading Variables

As a further test of the forward-looking properties of the credit spread, we regressed spreads on leads of some of the variables found in the exercise above to underly financial fragility, namely debt—GDP, real GDP, nominal and real interest rates. The ranges chosen were for one, two and three years ahead. The underlying assumption is that markets have rational expectations of future values of these variables which are centred on actual outturns.

Results are shown in Table 8. As in the other tests, U.S. results are similar to those for the U.K. over 1968–77, while there are sharp contrasts for the

TABLE 8
REGRESSION OF CREDIT QUALITY SPREADS ON LEADING VARIABLES

	U.K. *1968–1989*	*U.S.* *1960–1988*	*U.K.* *1968–1977*	*U.K.* *1978–1989*
Constant	0·04	0·09	0·20	−0·7
	(1·4)	(1·8)	(3·6)	(2·8)
$\Delta_4 Y_{t+4}$	—	−2·3	−6·9	10·6
		(1·8)	(2·4)	(2·9)
$\Delta_4 Y_{t+8}$	—	—	—	7·4
				(2·2)
$\Delta_4 Y_{t+12}$	−1·5	—	−1·9	—
	(1·6)		(1·8)	
$\Delta_4 D/Y_{t+4}$	—	—	—	—
$\Delta_4 D/Y_{t+8}$	—	—	1·4	
			(2·4)	
$\Delta_4 D/Y_{t+12}$	—	—	—	—
$\Delta_4 R_{t+4}$	−0·024	—	—	−0·08
	(2·6)			(3·6)
$\Delta_4 R_{t+8}$	—	—	—	—
$\Delta_4 R_{t+12}$	—	—	—	—
$\Delta_4 RR_{t+4}$	−0·011	0·015	—	0·07
	(2·3)	(1·5)		(2·4)
$\Delta_4 RR_{t+8}$	—	0·02	—	0·18
		(1·9)		(3·1)
$\Delta_4 RR_{t+12}$	—	−0·025	—	0·16
		(2·4)		(2·9)
$\bar{R}^2$	0·13	0·13	0·31	0·25
SE	0·20	0·29	0·19	0·17

U.K. over 1978–89. Both for the U.S. and the earlier period in the U.K., spreads rise when GDP is about to decline. For the U.S., spreads also rise in advance of rising real interest rates, while, in the earlier period in the U.K., rising spreads precede rising corporate debt-GDP ratios. All of these results are consistent with heightened financial fragility. In contrast, in the later period in the U.K., spreads rise in advance of rising real GDP—which would be correlated with increased issuance, in line with the market segmentation hypothesis. As in the U.S., spreads rise prior to increases in real rates but also in advance of declines in nominal rates. These results are at most only partly consistent with a relationship between spreads and expected financial fragility.

Market Segmentation and the Determination of Spreads

Given the thrust of the results outlined above, we sought to test directly for effects of market segmentation by assessing whether relative issuance in the corporate and public bond market affects spreads. For this exercise, we estimated an equation for spreads using a specification similar to Wadhwani (1986). We note that the dynamic structure of this equation is backward looking[20] and hence less consistent than the tests outlined above with the forward-looking properties of spreads. This criticism is less valid for the cointegrating vector, however, from which many of the results in this and the following section are obtained. For the cointegrating vector shows the long-run relationship between the variables, independent of the leads and lags present in the dynamic relationships.

Cointegrating vectors are shown in Table 9. Notable features of the U.K. spreads vector are the negative effect of short nominal and real rates (this also implies that inflation has a positive effect on spreads). The negative correlation of interest rates and spreads was also shown in the charts and may relate to counter-cyclical monetary policy. Other variables have signs as expected; a high debt-income ratio boosts spreads, as do high real wages and low GDP. For the U.S., real short rates have a positive effect, as might be anticipated, while nominal short rates again have a negative effect. The debt-income ratio has a strong influence with expected positive sign. Note that these results are largely consistent with the tests on leading variables reported earlier in Section VI.

The final dynamic estimates for spreads are shown in Table 10. For the U.K., the equation gives a positive short-run effect to rising debt income ratios and GDP (both at the fourth lag) and a negative influence to real wages. Results for the U.S., in contrast, have a negative short-run effect for births,

[20]However, the "Hendry" argument for such error correction equations suggests that the lags themselves constitute an expectations formation mechanism—hence the equation can be interpreted as forward looking.

TABLE 9
SPREADS EQUATION: COINTEGRATING VECTOR

	U.K. 1968–1989	*U.S. 1961–1988*	*U.K. 1968–1977*	*U.K. 1978–1989*
Constant	−21·5	−15·1	−9·9	−33·5
	(3·9)	(7·4)	(0·3)	(2·0)
Log birth ratio	−1·22	2·64	−0·89	−0·12
	(6·8)	(7·8)	(1·8)	(0·3)
Log debt/GDP	1·64	9·14	2·69	−1·82
	(5·7)	(6·6)	(4·2)	(1·3)
Log real GDP	−2·28	—	−0·73	−0·71
	(3·0)		(0·3)	(0·4)
Log real wages	6·39	−6·0	2·28	5·94
	(8·7)	(4·2)	(1·2)	(5·0)
Log real raw materials prices	—	—	—	—
Real short rate	−0·023	0·075	−0·044	0·012
	(4·2)	(3·3)	(3·5)	(0·5)
Nominal short rate	−0·038	−0·075	−0·024	−0·049
	(3·3)	(2·8)	(0·7)	(2·8)
$\bar{R}^2$	0·69	0·57	0·67	0·79
SE	0·24	0·47	0·24	0·20
DF	−5·3	−4·2	−4·3	−2·9
ADF	−4·2	−4·5	−3·6	−1·9
CRDW	1·0	0·6	1·2	0·9

debt income ratios, GDP, raw materials prices and real rates. These may proxy the consequences of an economic downturn, while the U.K. variables (at long lags) may proxy the end of the previous boom. The cointegrating residuals were significant in each case.

Looking at the split U.K. sample, the 1968–77 cointegrating vector closely resembles the whole sample, while the later period has a number of changes of sign. For spreads, the dynamic relationship weakens considerably in the later period, with only the cointegrating vector residual being significant. This suggests that the determination of spreads changes significantly between subperiods, in line with the hypothesis of deteriorating market efficiency.

The variable chosen to test for market segmentation was the difference between corporate and public issuance scaled by nominal GDP. Because the variable is often negative (a range of 6 per cent to −10 per cent), it was entered linearly. If segmentation is present, increased corporate issuance should raise the spread, as should reduced public issuance. Hence a positive sign indicates segmentation. The results are given in Table 11. In terms of levels, all but the most recent period for the U.K. has a negative sign, contrary to segmentation. The negative sign may reflect the relative increase in public issuance during recessions. In contrast, for the U.K. over 1978–89, the ratio had a positive sign, significant at 90 per cent level. This suggests that segmentation may have been an important factor over this period and may help to explain the other

TABLE 10
SPREADS EQUATION: DYNAMIC ESTIMATES
(For Mnemonics, see Table 4)

U.K.: 1969–1988

$$\Delta_1 YS = \underset{(3\cdot4)}{2\cdot65\Delta_1 \ln D/Y_{t-4}} + \underset{(2\cdot7)}{4\cdot4\Delta_1 \ln GDP_{t-4}} \underset{(3\cdot3)}{-4\cdot8\Delta_1 \ln RW_{t-1}} - \underset{(2\cdot6)}{0\cdot24RES_{t-1}}$$

$\bar{R}^2 = 0\cdot26$, SE = 0·18, DW = 2·0, Forecast(4) = 0·09, LM(4) = 5·9, BJ(2) = 0·2, ARCH(1) = 0·1, RESET(3) = 2·9

U.S.: 1962–1988

$$\Delta_1 YS = \underset{(5\cdot3)}{0\cdot27} - \underset{(2\cdot0)}{0\cdot78\Delta_1 \ln PBt_{-4}} \underset{(2\cdot6)}{-5\cdot3\Delta_1 \ln D/Y_t} - \underset{(5\cdot0)}{13\cdot7\Delta_1 \ln GDP_t} \underset{(4\cdot8)}{-3\cdot9\Delta_1 \ln RRM_t} - \underset{(3\cdot3)}{0\cdot053\Delta_1 \ln RR_t} \underset{(3\cdot9)}{-0\cdot2RES_{t-1}} + \text{seasonals}$$

$\bar{R}^2 = 0\cdot51$, SE = 0·22, DW = 1·8, Forecast(4) = 11·7, LM(4) = 2·8, BJ(2) = 1·1, ARCH(1) = 0·2, RESET(3) = (3) = 13·8

U.K.: 1969–1976

$$\Delta_1 YS = \underset{(3\cdot3)}{2\cdot9\Delta_1 \ln D/Y_{t-4}} + \underset{(3\cdot0)}{6\cdot6\Delta_1 \ln GDP_{t-4}} \underset{(3\cdot6)}{-6\cdot8\Delta_1 \ln RW_{t-1}} - \underset{(1\cdot1)}{0\cdot2RES_{t-1}}$$

$\bar{R}^2 = 0\cdot55$, SE = 0·16, DW = 1·9, Forecast(4) = 10·6, LM(4) = 2·8, BJ(2) = 2·3, ARCH(1) = 1·2, RESET(3) = 4·1

U.K.: 1979–1988

$$\Delta_1 YS = \underset{(1\cdot1)}{-1\cdot7\Delta_1 \ln D/Y_{t-4}} + \underset{(0\cdot8)}{1\cdot7\Delta_1 \ln GDP_{t-4}} \underset{(0\cdot3)}{+0\cdot86\Delta_1 \ln RW_{t-1}} - \underset{(3\cdot2)}{0\cdot5RES_{t-1}}$$

$\bar{R}^2 = 0\cdot2$, SE = 0·16, DW = 1·8, Forecast(4) = 1·8, LM(4) = 5·1, BJ(2) = 0·1, ARCH(1) = 0·3, RESET(3) = 2·6

TABLE 11
PRIVATE LESS PUBLIC ISSUANCE* IN SPREADS EQUATION (COEFFICIENT AND t-VALUE)

	U.K. *1968–1989*	*U.S.* *1961–1988*	*U.K.* *1968–1977*	*U.K.* *1978–1989*
Level in cointegrating vector	−0·6 (0·6)	−11·1 (4·6)	−1·5 (1·3)	3·0 (1·8)
Differences in dynamic estimate	$-1\cdot0\Delta_1 PPI$ (1·7)	$1\cdot77\Delta_1 PPI$ (1·5) $-1\cdot5\Delta_1 PPI_{-2}$ (1·2)	—	$2\cdot27\Delta_1 PPI_{-3}$ (1·8)

$$*\ PPI = \text{Level of ratio } \frac{(\text{Corporate bond issuance} - \text{Public bond issuance})}{\text{Nominal GDP}}.$$

results. Similarly, for differences there was a positive coefficient on the third lag with a t of 1·8. In the other regressions, the differences were negative, or insignificant, or both.

Comparing Cointegrating Vectors for Spreads and Default

Comparing the long-run results for spreads with those for defaults reported above, one can assess whether they are cointegrated with similar variables and with similar signs. This would suggest accurate reflection of default risk by spreads. Comparison reveals that the U.S. cointegrating vectors for spreads and defaults have exactly the same sign pattern (if one excludes insignificant variables), while the U.K. equations have marked differences (debt-GDP, real interest rates). This suggests that bond markets in the U.S. efficiently reflect default probabilities, while those in the U.K. do not.

VII Summary of Results

Broadly, the results suggest that U.K. spreads behaved similarly to those in the U.S. during the 1960s and 1970s, but behaviour has changed somewhat over the 1980s. Because of the influences of this later period, the results for the whole sample in the U.K. are relatively poorly determined. The results are summarized in the table below:

Test No.	U.S. and U.K. (1968–77)	U.K. (1978–89)
(i)	Spreads improve the predictive power of simple autoregressions in bankruptcies and GDP.	Spreads are significantly positively related to GDP.
(ii)	Spreads improve the predictive power of bankruptcy functions in both long and short run.	Spreads are insignificant in a dynamic equation for bankruptcies and negatively related to bankruptcies in the long run.
(iii)	Spreads help to predict a variety of leading variables associated with financial fragility.	Although spreads rise in advance of higher real interest rates, they also rise in anticipation of higher economic growth.
(iv)	Spreads either respond negatively or not at all to higher issuance in corporate relative to public bond markets.	Spreads respond positively to higher relative issuance in corporate bond markets.

(v)	Spreads respond to similar variables to defaults in the long run (in the U.S. only).	Spreads and defaults respond in the long run to different variables, or with opposite signs, in all subperiods in the U.K..

VIII Conclusions

Subject to the limitations of the data and the analytical techniques employed, as well as possible alternative interpretation which can be put on the results, the empirical results suggest the following tentative conclusions:

—Bond markets in the U.K. are currently less efficient than those in the U.S. in predicting and reflecting both default risk and the cycle, although they were equally efficient in this sense in the 1960s and 1970s.
—There is some evidence of behaviour consistent with market segmentation[21] in the U.K. in the most recent period—spreads seem to be positively related to GDP, negatively related to defaults and positively related to relative issuance in corporate and public bond markets.

Other results of interest are that:

—U.S. spreads are sensitive leading indicators of both defaults and activity.
—High real interest rates are important long-run determinants of bankruptcy in both countries, while nominal short rates appear to have had a negative long-run effect. In the U.K., these effects are reversed in the short run.
—Spreads and defaults in the U.S. are determined by virtually the same factors in the long run.
—Corporate debt-GDP ratios have a major role to play in explaining both defaults and spreads in the U.S..

The main conclusions imply that long-term yield spreads are not useful monetary indicators in the current state of the sterling bond market and that their recent increase and high current level may not foreshadow recession and rising defaults at a macroeconomic level in a measurable or predictable manner. It would, of course, be wrong to disregard them entirely. The results also suggest that risk may be inaccurately priced in the U.K. domestic bond markets (because spreads do not reflect default risk), an inefficiency which may lead to underuse of the market for primary issuance. To the extent that Eurosterling spreads follow similar patterns, that market will also be affected.

[21]However, the evidence is also consistent with changes in relative liquidity. And both segmentation and low liquidity could be consequences of the deterioration of market infrastructure highlighted in Section III.

In contrast, spreads in the U.S. appear to be useful forward-looking indicators of future economic conditions and indications are that risk is accurately priced.

Further work in this area could address, *inter alia*, the following issues: (i) What is the role of liquidity in the sensitivity of bond yields? (ii) Do credit spreads forecast better in a multivariate VAR, i.e., in combination with other spreads and indicator variables? (iii) Even if spreads do not track all movements in GDP, are they still useful in finding turning points? (iv) Do the results still hold with alternative specifications for bankruptcy?

References

Bernanke, B. S. (1983). "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression", *American Economic Review*, Vol. 73, No. 3, pp. 257–276.

Breedon, D. T. (1979). "An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities", *Journal of Financial Economics*, Vol. 7, No. 3, pp. 265–296.

Burns, A. F. and Mitchell, W. C. (1946). *Measuring Business Cycles*, New York, NBER.

Dale, R. and Thomas, S. (1990). *Financial Times Bond Ratings Guide*, London, FT Publications.

Davis, E. P. (1987). "Rising Sectoral Debt-Income Ratios: A Cause for Concern?", Bank for International Settlements, *BIS Economic Papers No. 20*.

Fisher, L. (1959). "Determinants of Risk Premiums on Corporate Bonds", *Journal of Political Economy*, Vol. 67, No. 3, pp. 217–237.

Fons, J. S. (1986). "The Default Premium and Corporate Bond Experience", *Federal Reserve Bank of Cleveland Working Paper 8604*.

Friedman, B. M. and Kuttner, K. N. (1989). "Money, Income and Prices after the 1980s", *NBER Working Paper No. 2852*.

Hickman, W. B. (1958). *Corporate Bond Quality and Investor Experience*, Princeton, N.J., Princeton University Press.

Jaffee, D. M. (1975). "Cyclical Variations in the Risk Structure of Interest Rates", *Journal of Monetary Economics*, Vol. 1, No. 3, pp. 309–325.

Keim, D. B. and Stambaugh, R. F. (1986). "Predicting Returns in the Stocks and Bond Markets", *Journal of Financial Economics*, Vol. 17, No. 2, pp. 357–390.

Lund, T. (1990). "Sterling Spreads—What is to be Done?", *Credit Suisse First Boston Research Note*.

Malkiel, B. G. (1985). *A Random Walk down Wall Street* (4th edition), New York, W. W. Norton.

Merton, R. C. (1974). "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates", *Journal of Finance*, Vol. 29, No. 2, pp. 449–470.

Pratt, M. and Simpson, P. (1988). "Recent Developments in the Corporate and Bulldog Sectors of the Sterling Bond Market", *Bank of England Quarterly Bulletin*, Vol. 28, No. 1, pp. 62–68.

Robinson, R. I. and Wrightsman, D. (1980). *Financial Markets* (2nd edition), New York, McGraw-Hill.

Shiller, R. J. (1981). "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?", *American Economic Review*, Vol. 71, No. 3, pp. 421–436.

Stiglitz, J. E. and Weiss, A. (1981). "Credit Rationing in Markets with Imperfect Information", *American Economic Review*, Vol. 71, No. 3, pp. 393–410.
Stock, J. H. and Watson, M. W. (1990). "New Indexes of Coincident and Leading Economic Indicators", NBER, mimeo.
Wadhwani, S. B. (1986). "Inflation, Bankruptcy, Default Premia and the Stock Market", *Economic Journal*, Vol. 96, No. 381, pp. 120–138.