Implicit interest rates and corporate balance sheets: an analysis using aggregate and disaggregated UK data

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Abstract

Credit channel models emphasise the importance of financial variables in macroeconomic responses to unanticipated economic events. In this paper empirical models are developed that relate implicit interest rates paid by firms to measures of their financial health (principally capital gearing) using both aggregate data and information from individual company accounts. Both aggregate and disaggregated approaches confirm a significant influence on interest rates from changes in the financial health of companies. The aggregate relationship finds support for the hypothesis that implicit interest rates depend on the initial level of indebtedness in a non-linear way. The estimated equation is used within the Bank of England's macroeconomic model (extended to incorporate the balance sheets of the corporate and household sectors) to simulate the role of the credit channel mechanism in response to shocks.

Summary

This paper examines evidence for effects on the cost of corporate debt finance from net worth. The central issue we address, confronted with data at both the aggregate and individual company levels, is whether implicit corporate interest rates reflect the strength of corporate balance sheets. In particular, such an effect is emphasised by the credit channel of the financial accelerator literature.

The analysis begins by exploring measures of implicit interest rates, deriving aggregate data from national accounts. Using a simple conceptual framework the paper estimates single time series models that relate implicit interest rates to risk-free rates and measures of corporate indebtedness. It finds evidence for a non-linear role for capital gearing, where gearing only changes the implicit interest rate when it is at relatively high levels. This is consistent with the prediction from the financial accelerator literature that balance sheet weakness should give rise to an increase in the external finance premium, although that does not depend on non-linearity.

The paper also uses company-level data to relate implicit rates to balance sheet measures of gearing and liquidity. Although non-linear effects are not found, the results confirm a significant positive relationship between implicit interest rates and balance sheet conditions.

Finally, the possible quantitative role that the finance premium may play in the propagation of shocks is considered. Simulations are presented using the time series equation in an aggregate macro model. The results show that implications for corporate liquidations can be quite sensitive to the presence of the non-linearity, although the sensitivity depends on the source of the shock.

1. Introduction

Economic models typically assume that changes in financial conditions can be summarised by a small set of financial variables, including short-term risk-free interest rates and long-term government bond rates. However, 'credit channel' models consider how changes in the financial positions of borrowers and lenders can affect the relationship between interest rates and spending and inflation, so that financial factors can influence the transmission of monetary and real shocks. Hall (2001a) discusses the two main channels involved. First, there is the bank lending channel. Any unanticipated economic change that weakens the balance sheets of banks might cause them to reduce the supply of bank loans. High-quality borrowers might be able to substitute other forms of finance with little change in finance costs. But other borrowers may be unable to switch sources of finance readily and so may face a rise in finance costs or a tightening in non-price conditions. Second, there is the balance sheet channel. Unanticipated events that reduce the cash flow of borrowers may increase their need for external finance. Alternatively, the shock may directly weaken the balance sheet of borrowers (for example, by reducing the value of collateral held against loans). Kiyotaki and Moore (1997) emphasise the role of collateral in lending decisions. In the absence of full information about the economic and financial health of borrowers, lenders may require a higher premium on loans, as they perceive a higher risk of default as demand for external finance increases and borrowers' balance sheets deteriorate. This raises the cost of debt finance for borrowers, and so the cost of capital. This second alternative is the mechanism commonly associated with the external finance premium model of Bernanke, Gertler and Gilchrist (1999). In their model corporate net worth determines the size of this external premium, and the operation of this mechanism increases the amplitude of the investment response to economic shocks (the so-called 'financial accelerator effect'). It is this second aspect that is considered in this paper.

These mechanisms are consistent with other approaches that emphasise the role of financial factors on real activity. In particular the Merton approach (Merton (1973)) implies that an increase in indebtedness increases the probability of default (and hence the risk of liquidation) for any given level of market capitalisation and asset volatility.

The Bank of England's Monetary Policy Committee outlines several ways in which changes in monetary policy work through to real activity in its report on the transmission mechanism of monetary policy (1999).[1] There are two possible routes related to the credit channel models that are commonly excluded from standard macroeconometric models (including the Bank's medium-term macroeconometric model (MTMM)). Unanticipated economic events that reduce output and cash flow for firms raise the proportion of a given investment that must be financed from external funds. This increases the expected monitoring costs of the lenders and raises the external finance premium. In the face of this, firms may decide that investment remains profitable

[1] See Monetary Policy Committee (1999).

and be prepared to take on new debt at the higher borrowing rate, in which case their income gearing (debt service) will rise, further weakening their balance sheet position. Alternatively, they may defer or cancel their proposed investment, leading to lower output at the macroeconomic level (see Hall (2001b)) for a calibration of this effect for the United Kingdom). The second transmission channel operates through asset prices. If these decline following a shock, the value of collateral available to back loans is reduced, also raising the external finance premium. The overall effect is to increase the amplitude of responses of output, investment, and corporate cash flow to shocks. This provides grounds for the hypothesis that more heavily indebted corporate sectors will be more vulnerable to adverse economic shocks.

The emphasis of much of this previous work on credit channel models has been to analyse and identify the effects of changes in the external finance premium on output and investment using calibrated models. Hall and Vila Wetherilt (2002) argue that further work to develop quantitative models that incorporate some of these features may provide further insights into interactions between monetary and financial stability. The external finance premium itself is not observable. It will depend on the level of default risk and the degree of collateral available to support lending. A small change in the risk of default can produce a large change in the interest premium charged. For some companies this will be sufficient to lead them to default on their loans. The true effective rate premium will depend on the rates charged to both defaulting and non-defaulting firms.[(2)] However, in practice, we can only observe the difference between the interest rate charged and the risk-free rate for surviving firms. This will clearly understate the true premium. In what follows we call the interest rate measure we derive the 'implicit' rate. Further avenues of work might consider the measurement of the implicit rate for companies that default and how this influences corporate liquidations. However, to do this would require more detailed data than are currently available.[(3)] The approach also only identifies the price effects of credit changes. It is possible that changes in credit risk will be reflected in changes in the terms of lending other than its price. This is also a possible direction of further research.

The role of this paper is in deriving measures of the implicit interest rate faced by surviving firms and providing an empirical model of the relationship of this interest rate to measures of the health of corporate sector balance sheets. The measures themselves can be used in explaining corporate investment, although that is beyond the scope of the present paper.

This implicit rate of interest paid by firms is measured from both aggregate and company-level accounts data. The empirical estimates, both across time and across companies, support the hypothesis that higher levels of capital gearing raise the implicit interest rate paid by companies relative to measures of the short-term risk-free rate and the long-term government bond rate. For

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[(2)] We are grateful to an external referee for this point.

[(3)] Available data allow us to identify firms that fail and become insolvent together with their financial characteristics in their previous published annual report. But details of interest payments and outstanding debt immediately prior to default are only available for companies with public debt.

companies able to access international markets, the implicit interest rate will also be influenced by international interest rates and the currency composition of lending. But it is the actual rate paid, rather than the notional rate, that gives a more accurate indication of the potential sensitivity of companies to economic shocks.

The paper is organised as follows. The second section describes the estimates of the implied interest rate from aggregate data, contrasting ONS data with estimates of implicit interest rates from the data collected by the Bank of England from a survey of UK banks. Then these aggregate estimates, which cover both public and private UK companies, are compared with estimates derived from quoted UK company accounts. Section 3 develops empirical models at both the aggregate and individual company level to explain implicit interest rates by measures of risk-free rates and indicators of financial indebtedness (capital gearing), in the spirit of the theory of the external finance premium. Both approaches find a significant role for capital gearing. In addition, the aggregate approach finds a significant non-linearity, whereby increases in capital gearing only raise implicit interest rates when gearing is already above its average historical level. The fourth section considers the possible role that the analysis may play in the propagation of certain shocks. This analysis employs the extension of the Bank's macroeconometric model (MTMM) developed by Benito, Whitley and Young (2001) to examine the possible role of the model of the implicit interest rate in explaining corporate liquidations and corporate financial stress. The final section draws some conclusions and suggestions for further work. Our discussion is motivated by the aim to derive data on implicit corporate interest rates that can be updated regularly and used, rather than to derive definitive estimates of the 'true' external finance premium.

2. Measures of the aggregate implicit interest rate

2.1 Conceptual background

In each period the average interest rate paid on borrowings will depend on how much borrowing is at fixed or at floating rates, how much is short term or long term and how rates of interest at various maturities move in relation to each other. To help fix ideas a simple model is set out where firms borrow either short term or long term, but not both. The average implicit interest rate on new debt is then given by:

$$REFF(t) = \alpha \; RSEFF(t) + (1\text{-}\alpha) \; RLEFF(t) \qquad \textbf{(1)}$$

α is the proportion of short-term debt and is given by $\alpha = DEBTS/(DEBTS+DEBTL)$.
DEBTS is the amount of short-term debt outstanding and may be thought of as bank borrowing, and *DEBTL* is the amount of long-term debt, mainly bond finance. *RSEFF* and *RLEFF* are the respective implicit interest rates. For simplicity short-term borrowing interest rates can then be defined as the spread plus the risk-free rate.

Thus:
$RSEFF(t) = RS(t) + \pi_1(t)$ and $RLEFF(t) = RL(t) + \pi_2(t)$ where π_1 and π_2 are the implicit premia for surviving firms.

If we make the simplifying assumption that these spreads are equal at different maturities (ie $\pi_1 = \pi_2 = \pi$) then **(1)** can be rewritten as:[(4)]

$$REFF(t) = \alpha\ RS(t) + (1-\alpha)\ RL(t) + \pi(t) \qquad \textbf{(2)}$$

where *RS* and *RL* are the respective risk-free rates on short-term and long-term debt.

This simple model assumes both that there is no existing debt at the beginning of the period and that debt is all at floating rates. If instead we assume a two-period model where debt is at fixed rates and all short-term debt expires within one year we obtain:

$$REFF(t) = (DEBTS(t)*(RS(t) + \pi(t)) + \Delta DEBTL(t)*(RL(t) + \pi(t)) + (1-\gamma)*DEBTL(t-1)*(RL(t-1)+ \pi(t-1)))\ /\ (DEBTS(t)+DEBTL(t)) \qquad \textbf{(3)}$$

The implicit interest rate now takes into account that new debt taken on in period t might have a different maturity structure to that at t-1, and that a proportion of long-term debt (given by γ) will have been repaid or matured. A simple simulation model demonstrates that the implicit interest rate can change merely because of shifts in the maturity structure. Changes in either risk-free rates or in the external finance premium are not necessarily reflected in equi-proportionate changes in the interest rate paid by firms. In practice, the identity determining the implicit interest rate faced by the UK non-financial corporate sector is far more complicated than this simple model for some of the reasons outlined below.

First, we have described a simple two-period model where there are only two types of debt. This ignores information from the complete term structure. Second, the effect of changes in short-term interest rates on the implicit rate depends on how much debt is at fixed rather than variable rates. Third, the simple model assumes that debt information is available in terms of original maturity. In practice, available information only records residual maturity. Some loans of less than one year to residual maturity may have been originally of a longer maturity and so carried a different premium. Finally, the simple model corresponds to a closed economy and ignores borrowing from abroad.

One way to proceed would be to try and fill in these gaps. This is not attempted in this paper as not all the requisite information is easily available, especially over time on a comparable basis. For modelling purposes we need to incorporate a time dimension into the analysis, especially at the aggregate level. There is clearly a trade-off between the simplicity needs of an empirical model and the requirements for a thorough explanation of the implied corporate interest rate. This paper leans heavily in the direction of simplicity, but uses the disaggregate analysis to confirm and reinforce the aggregate findings.

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(4) This is not an assumption made in the empirical modelling below but made here for expositional reasons.

The implicit rate itself can be calculated quite simply by dividing total interest payments by total debt outstanding. We now discuss measures based on different data.

2.2 Aggregate data

The first measure is derived from aggregate ONS data from the national accounts. Estimates of the aggregate implicit interest rates for private non-financial companies (PNFCs) are calculated for each quarter from 1988 directly by dividing interest payments in the income and expenditure account by the level of outstanding gross debt. ONS practice is to record interest payments on an accruals basis and allocate them across sectors according to a dividends and interest matrix which shares out payments according to measures of outstanding debt. This implies that there is already some specific assumption about debt in the construction of the interest payment data. Measures of gross debt can be obtained from the national accounts data on the balance sheets of PNFCs by combining amounts outstanding of bonds, loans, and money market instruments. We exclude direct investment loans as these include intra-company loans between a parent company and its subsidiary. Appendix A gives further details of the composition of gross debt and Table A below summarises the key elements of debt.

In the empirical model we use an estimate of the relative proportion of short and long-term debt. An approximation to this can be made by distinguishing between elements of debt that are less than, and more than one year to maturity. On this basis the proportion of short-term debt has fallen from around 74% in the late 1980s to around 61% in 2000. But this split is only approximate as the allocation between short-term and long-term debt is itself imprecise. Further, debt is measured at residual maturity rather than original maturity. Although this approximation between short-term and long-term debt may be a poor one there is little practical alternative.

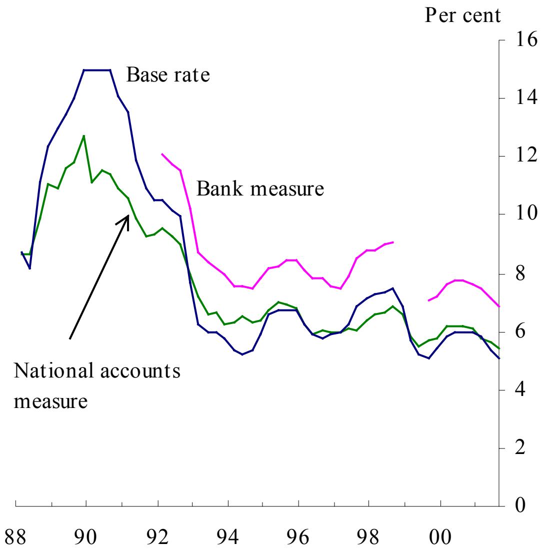
Table A
Components of PNFC gross debt at end-2000 (£bn)

Securities other than shares	200.2
Loans:	404.4
£ loans by UK financial institutions	203.1
Foreign currency loans by UK financial institutions	45.9
Loans by non-UK resident financial institutions	97.4
Other loans	40.0
Finance leasing	18.0
TOTAL	**604.6**

Source: National Statistics.

The average implicit corporate interest rate derived in this way is shown in Chart 1. A complementary measure is the average rate of interest charged by banks. The Bank of England has conducted a survey on an informal quarterly basis from 1992 that has been used to assist the compilation of the national accounts data described above. This was on an experimental basis and the Bank of England has now concluded that the returns were sufficiently reliable to publish monthly data from January 1999. These data are shown in Chart 1 alongside the measures derived from the national accounts data and the London clearing banks' base rate.

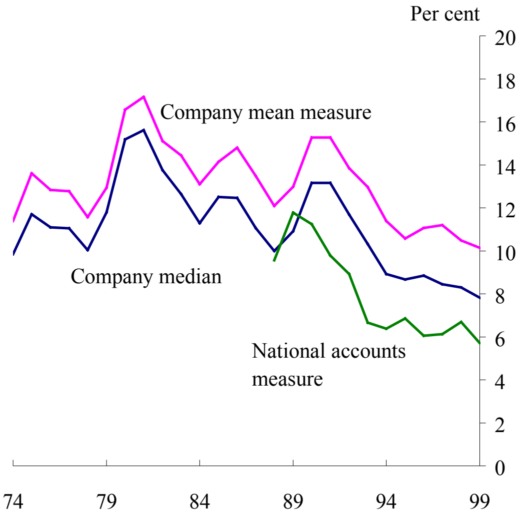
Chart 1
Measures of aggregate interest rates—quarterly data 1988-2001 Q3



Sources: ONS and Bank of England.

The *movement* of the series derived from the national accounts data is very similar to that from the Bank of England's survey of banks. This is not unexpected, as the Bank's measure is used as part of the national accounts measure. However the *level* of the implicit interest rate is consistently lower for the national accounts measure, and also occasionally lower than the base rate. This may be explained by the different coverage of the data. The national accounts series includes interest due to all lenders relative to all PNFC debt whereas the Bank's survey only includes charges made by UK resident banks. More importantly, the national accounts data include interest payments on bonds (around one-third of interest payments). These interest rates are derived on a bond-by-bond basis. For variable-rate bonds LIBOR is used; for fixed-rate bonds the coupon rate is applied. For example, in 2001 Q3 the average implicit interest rate implied by ONS data is 5.4%. Given that the data from the Bank's representative interest rate survey for the same period gives a figure of 6.9% for bank loans, the implied interest rate on bonds is around 2.5%. The reason for the low rate is that ONS only measure the actual interest rate paid, so that zero-coupon and deeply discounted bonds lower the implicit rate, and the discount is implicitly treated as a capital gain.

Chart 2
Implicit aggregate interest rates—annual data 1988-99



Sources: ONS and Bank of England.

2.3 Company accounts data

We now turn to estimates of implicit interest rates at the individual company level. The data employed are derived from company accounts records held on Datastream, the on-line service covering all companies quoted on the London Stock Exchange. The data refer to non-financial companies over the period 1973 to 2000.

A company-specific estimate of the cost of debt, or company interest rate, is constructed using these company-level data. Again the implicit interest rate is defined as the ratio of interest payments to gross debt but is annual and covers a longer sample period to that used for the aggregate analysis above (so implicitly it treats interest on bonds in the same way as the ONS data). From these data we can also describe the distribution of this variable over time.[5]

The company data used are for all UK quoted companies whereas the national accounts data refer to all companies, listed or otherwise. There were around 1,300 listed companies in 2000 with aggregate debt of £259 billion. The distribution of debt is skewed and median debt in 2000 is £6.4 million. Total PNFC debt is £606 billion in 2000 but spread over 1.3 million companies. It is not surprising that average debt should be larger for quoted companies as they are larger in size than non-quoted companies. A large part of the debts of private companies are those of a subsidiary of a listed parent company and in terms of analysis might be better included on a consolidated basis. That is not done here.

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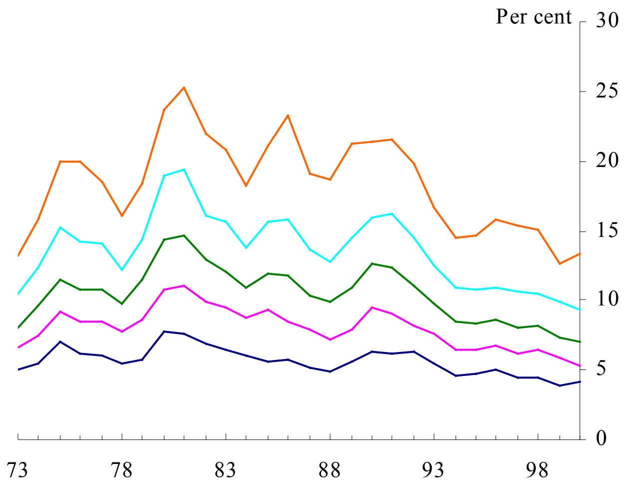
[5] A number of recent studies of firm behaviour have employed this variable (for example, Von Kalckreuth (2001); Chatelain and Tiomo (2001); Bover and Watson (2000)).

We can identify the proportion of short-term debt from company accounts using the amount of debt of less than one year. This proportion is much lower than that implied for all companies from the national accounts data. Short-term debt accounts for around 30% of total debt for listed companies compared with double that (ie around 60%) for all companies. Moreover bank finance is only 10% of total debt for listed companies (30% of short-term debt); considerably lower than the 30% share of bank finance in total debt for all companies.

Chart 3 illustrates different percentiles, in the cross-sectional distribution of implicit interest rates. A number of features stand out. First, the median implicit interest rate is indicative of the 'typical' company in each year. This follows a similar profile to that for the aggregate implicit rate and the base rate. Second, there is considerable variation across companies in their implicit interest rate. Over the full period 1973-2000 and the 2,055 companies, the 5th percentile is 3.8% while the 95th percentile is 24.4%. Part of this variation reflects variation across years (some of which may be common across companies), but Chart 3 shows that even in a given year there is a great deal of variation across companies in the implicit cost of debt they experience. For instance, in 2000 the implicit rate of interest at the 10th percentile is just below 5% while that at the 90th percentile is nearly 15%. Third, this variation across companies tends to increase as base rates rise (for example, in the late 1980s). This may suggest that those firms already experiencing relatively high interest rates are more vulnerable when credit conditions are tightened. It is also notable that the variability and dispersion of implicit rates has been lower during the late 1990s when nominal interest rates have fallen in a low-inflation environment (see Chart 4).

Chart 3
Distribution of implicit interest rates



Sources: Thomson Financial Datastream and Bank of England.

Note: 10th, 25th, 50th, 75th and 90th percentiles shown.

The estimate from aggregate data is lower than the mean of the interest rate for quoted companies alone (Chart 2). But, despite this level difference, movements of the two measures are remarkably similar.

One possible reason for this divergence between the two measures is the different coverage. The company measure is based only on quoted companies. One line of argument is that the implicit rate should be *lower* for public companies since they might be thought to be less risky than private companies, mainly because there is more information about them. That would imply that higher debt does not necessarily bring with it a higher risk of default and a higher external finance premium. Another possible explanation is that the national accounts data are territorial while the company accounts are global in nature. But the actions of subsidiaries are treated as foreign direct investment and unlikely to explain the difference between estimates of implicit interest rates between national accounts and company account measures.

There is, however, an explanation for some of the greater company variability between years in the corporate-based measures that can give unusually high (and low) values for the implicit interest rate in particular years. This arises from the difference in timing between cash flow statements and the year-end balance sheet used to construct the implicit interest rate (particularly where companies change the amount of debt by a large proportion during the course of the year). Appendix C illustrates a small number of examples of outlier companies from the distribution. Consider the unusually high values first, shown in Table C1. In the case of company 1, its implicit interest rates remained stable between 1996 and 1998 at around 10%. But in 1999 the company reduced its level of debt by some 80% while its interest payments fell by a more modest 7.2%; consequently its recorded implicit interest rate increased to 47.9%.

Chart 4
Distribution of the cost of debt less base rate

Note: 10th, 25th, 50th, 75th and 90th percentiles shown.

The likely explanation for this is that during the course of the year the company continued to pay interest on a level of debt similar to that recorded in its 1998 accounts. As it then reduces its level of debt, the year-end figure (recorded on the balance sheet) understates the level of debt on which the company is paying interest for much of the year. It should be emphasised that in conducting this exercise, we are deliberately focusing on the outliers which are, by definition, not representative of the vast bulk of the data. Nevertheless, one method of addressing this issue is to take a moving average of, say, three years of data on the debt figure centred on the year in question and use this as the denominator to calculate the implicit interest rate.[6] Particularly in the context of estimation work, this may be important since our analysis considers the hypothesis that the implicit interest rate paid by a company is a positive function of its debt. It should be clear from the above discussion that the timing difference between the cash flow statement and year balance sheet will tend to induce an inverse relation between the two: increases (reductions) in debt tend to accompany lower (higher) interest rates. The attempt to identify a financial accelerator type effect will need to overcome this tendency in the data and taking a 'debt-smoothed' implicit interest rate may help in this context.

3. Econometric analysis

3.1 National accounts/time series approach

We start by using the simple framework developed above that sets out the relationship between the implicit interest rate paid by firms and hence the implicit finance premium. We show that an approximation to the premium can be made by relating the average interest paid to a measure of the risk-free rate weighted by maturity. The theoretical literature tends to describe the finance premium relative to a single representative interest rate. In theory the external finance premium should be independent of the risk-free rate, changing only in response to the degree of external financing. But in practice many firms hold cash or liquid balances that could be used to substitute for external finance. The pecking order theory of corporate finance (Myers and Majluf (1984)) does not translate neatly to a situation where firms resort to external finance while holding cash. This suggests that firms may target net interest payments as a proportion of the outstanding stock of net debt as an alternative to the ratio of gross interest payments to gross debt. Those companies with significant interest-bearing cash holdings may be less sensitive to shifts in the external finance premium, although ultimately this is an empirical matter.

The key point to take from the simple model in the previous section is that differences between the implicit interest rate paid by firms and the risk-free rate may vary over time for reasons unconnected with any change in either any underlying external finance premium or risk-free rates. So a simple comparison of the implicit interest rate with measures of risk-free rates may not identify the 'pure' external finance premium. But modelling the implicit interest rate alongside measures of risk-free rates may enable us to extract that part of the difference that is related to external finance or capital gearing, especially if shifts in maturity structure are slow-moving. We call that component the external finance premium, recognising that it only relates to the rate paid by surviving firms.[7]

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[6] Centring on the current year implies that 't-1' refers to the previous year rather than six months earlier.
[7] The failure rate of companies has varied from around 1% in 2001 to a peak of 4% in the early 1990s.

The empirical model is applied to data for the period 1990 Q2-2000 Q4. A long run of data is not available from national accounts. The estimate of the proportion of short-term debt from national accounts data can only be regarded as very approximate, and represents an attempt to isolate some of the effects of changes in the yield curve on the implicit interest rate. The results are not very sensitive to different marginal assumptions about this proportion.

Estimation results are reported in Table B. Equation **(1)** includes a non-linear term in capital gearing at replacement cost.[8] It is equal to capital gearing when it is above the sample period average, and zero otherwise. This non-linearity is tested empirically by adding the aggregate gearing term, and finding it statistically insignificant (see specification 2). That suggests that judging potential lending criteria in terms of the change in the level of aggregate capital gearing may be misleading, it is the level itself that matters. The restrictions on the dependent variable implied by the share of short-term debt are not rejected. Diagnostic tests for serial correlation, functional form, normality and heteroskedasticity suggest a reasonably well-specified equation. The high coefficient on the lagged dependent term implies that the adjustment process is protracted for changes in capital gearing and that it takes four years for 60% of the full effect to work through.

In addition we include a term in the *change in* short-term (policy) interest rates. The underlying model (equation **(3)**) is deliberately simple and uses residual maturity rather than original maturity, and assumes floating-rate debt. So the relative weight on short-term and long-term interest rates may not correctly capture the implications for the implicit average rate of a change in floating-rate debt, either since debt is incorrectly assigned on the basis of residual maturity, or because some debt is at fixed rate. So this dynamic term is one way of allowing for these approximations. Since we do not know, *a priori*, the direction of any bias in the approximation the sign on the coefficient on this variable could be either positive or negative. In practice, it turns out to be negative. That could be consistent with some debt being at fixed rates and hence interest rates paid do not move equi-proportionately with the change in floating rates. Alternatively it could suggest that there is a lag between changes in market rates and changes in the base rate.

Sensitivity analysis on the equation suggests that it is gearing at replacement cost that is the key variable rather than gearing at market value (see specification 5). This may reflect some of the volatility of the market value series, deriving from short-term fluctuations in share prices. We also used a measure of external financing (the share of retained funds). This had a negative sign as expected but was not statistically significant. A non-linear term similar to that for capital gearing was also insignificant.

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[8] The two main measures of capital gearing considered are those at replacement cost and at market values. Capital gearing at replacement cost is defined as net debt of PNFCs as a per cent of capital sock at nominal replacement cost. Capital gearing at market value is net debt as a per cent of market value of the company's equity.

Chart 5 shows the relationship between the implicit aggregate interest rate and the weighted average of short-term and long-term interest rates. This shows a broad similarity but a difference that varies over time. Chart 6 plots this difference against capital gearing. After 1992 there is a positive association between the difference and capital gearing as expected.[9] But the large negative difference observed during 1990-91 is not matched by low capital gearing. Visual inspection of Chart 6 strongly suggests that the relationship between implicit interest rates and capital gearing changed after 1993. One hypothesis is that this is due to capital gearing previously being below some critical level. An alternative explanation is that some general structural change occurred after 1993, possibly reflecting a change in the behaviour of lenders. That would be consistent with the analysis of Hall and Vila Wetherilt (2002). They show that the effects of the corporate balance sheet on the monetary transmission depend additionally on the degree of accommodation of lenders. In order to distinguish between these alternative hypotheses we included both slope and constant shift dummies. But neither of these were statistically significant, whether the dummy variable was included for 1995, or for 1993 when implicit interest rates began to increase (see for example equation **(6)**). This does not rule out the mechanism identified by Hall and Vila Wetherilt but suggests that any changes in lending practices during this period are more complicated in their impact on effective interest rates than captured by these dummies.

The preferred non-linear term in capital gearing remains significant even when a time trend is added to the equation (equation **(7)**). The time trend itself is also statistically significant which suggests that there may be some trend factor affecting the relationship beyond that explicitly allowed for in the changing composition of short-term and long-term debt over the sample period.

In order to test whether changes in foreign borrowing rates were important in modifying the effect of corporate balance sheets on the implicit interest rate we included a term in world interest rates. However this variable was statistically insignificant (equation **(4)**).

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[9] The market value measure of capital gearing also increased after 1995 but less rapidly than at replacement cost (see the Bank of England's *Financial Stability Review*, June 2002, page 77).

Table B
Estimation results: Aggregate data
Dependent variable: Implicit interest rates less weighted average of short and long-term rates, as defined in **(2)**: *REFF(t)-RL(t) - α(t)(RS(t)-RL(t))*
Method OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	-0.0589 (1.0)	-0.37269 (1.1)	0.47166 (0.7)	-0.0329 (0.6)	0.0518 (1.1)	-0.1130 (1.5)	-1.298* (2.2)
Capital gearing *t*-1 (Positive dev.)	0.00642* (2.1)		0.01143 (1.9)	0.005577 (1.7)	-0.0024 (0.6)	0.00691* (2.1)	0.00647* (2.1)
Capital gearing *t*-1		0.01778 (1.3)	-0.0263 (1.0)				
Change in base rate	-0.14336* (2.2)	-0.1569* (2.3)	-0.1583* (2.4)	-0.0281 (0.1)	-0.2147* (3.1)	-0.1547* (2.3)	-0.1833* (2.8)
Lagged dependent Variable	0.9400* (25.5)	0.9391* (24.5)	0.9440* (25.4)	0.9328* (17.3)	0.9262* (19.2)	0.9257* (21.9)	0.8606* (15.8)
Difference between world and UK interest rates				0.00441 (0.1)			
Change in world interest differential				0.1522 (1.2)			
Time trend							0.0093* (2.1)
Dummy shift variable (=1 from 1995Q1)						0.0861 (1.1)	
Residual sum of squares	1.9196	2.0563	1.8712	1.8373	2.1192	1.851	1.705
Serial correlation (4)	3.6	1.2	4.8	4.0	0.3	6.0	5.3
Functional form	2.3	0.8	2.6	3.7	0.04	2.5	3.5
Heteroskedasticity	0.4	0.9	0.2	0.5	1.3	0.2	0.2
Restrictions (2)	3.2						

Sample period: 1990 Q2-2000 Q2; t-ratios in brackets.

Note: The gearing variable in (5) is at market value, elsewhere it is at replacement cost.

Chart 5
Weighted rate and implicit rates

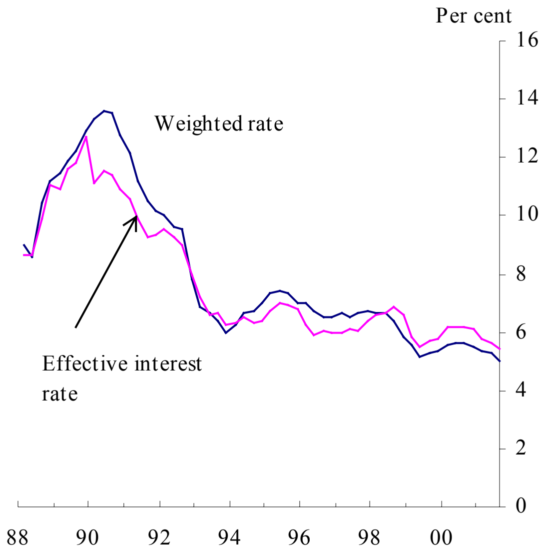
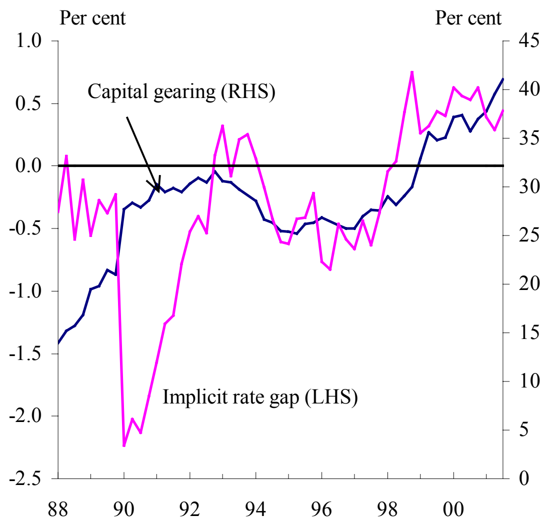


Chart 6
Capital gearing and implicit rate gap



3.2 Company-level results

We now consider the results at company level. Following the analysis above and the previous discussion of aggregate data, we consider the relation between the implicit rate, cash flow, indebtedness and cash assets. Estimation results are presented in Table C. These specifications explain the company implicit interest rate, both unadjusted and debt-smoothed, by cash flow, gross debt and total cash assets.[10] Our aim here is to exploit heterogeneity at the company level in order to consider the financial-accelerator-related hypothesis that deteriorations (improvements) in financial health increase (lower) the cost of finance. In Bernanke *et al* (1999), net worth is defined as borrowers' liquid assets plus collateral value of illiquid assets less outstanding obligations. Cash flow (normalised on replacement cost of assets, CF/K), capital gearing (B/K), and cash assets (C^{tot}/K) should act as empirically useful proxies. A control for the scale of the firm is also included (log real sales, y). Evidence of a significant inverse relationship between financial health and this interest rate variable is consistent with the financial accelerator approach.

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[10] Since the calculation of the three-year moving average involves the loss of the first and last observation per company and we maintain the selection that we have at least four time series observations, this results in a smaller sample size when using the 'debt-smoothed' interest rate variable.

The estimation method is the Blundell and Bond (1998) GMM-System estimator. This controls for fixed effects, year effects and instruments each of the company-level regressors (cash flow, debt and cash assets) with lags, estimating the equation both in first-differences (where lagged levels terms are used as instruments) and in levels (where a lagged difference term is used as instrument). The fixed effects control for all unobservable, time-invariant company-specific characteristics. This includes riskiness of the company's activities to the extent that this is constant over time. The year effects control for changes in the base rate across years and other changes that are common across companies. The key requirement for consistency of the estimator is the absence of second-order serial correlation in the first-differenced residuals. This is tested by the test statistic, M_2 (Arellano and Bond (1991)). We report both the robust one-step estimator results and the two-step estimates, where the latter use the one-step residuals as weights. Monte Carlo evidence suggests that the standard errors in the two-step estimates may be understated by around 10% (Arellano and Bond (1991); Blundell and Bond (1998)).

Consider the results for the unadjusted implicit interest rate first, presented in columns 1 and 2. The results indicate that the implicit interest rate is a negative function of the cash flow of the company, consistent with the hypothesis of the earlier discussion. The cash-assets terms are negatively signed but only significant under the two-step estimates. The gross-debt term is also only significant under the two-step estimates but more worryingly there is evidence of second-order serial correlation under this specification that would render the estimates inconsistent.

As discussed above the construction of the implicit rate term may be biased because of timing differences in the reporting of the interest payments and debt figures from the company cash flow statement and balance sheet. This will tend to induce a negative relation between debt and the implicit interest rate (as will measurement error in debt more generally) and may disguise any causal positive relationship between the level of debt and its cost. Estimates based on smoothed measures of the implicit interest rate are reported in columns 3 and 4 in Table C. These estimates confirm the findings from the unadjusted measures in terms of the relations between the implicit rate and cash flow and total cash held by the company. However, the adjusted interest rate regressions now provide evidence for a significant positive relation between the level of debt and the interest rate consistent with the hypothesis of a relationship between the cost of finance and net worth. These estimates confirm our priors described previously.

An additional hypothesis considered in the light of the aggregate evidence which pointed to a non-linear effect in gearing, was to add squared terms in each of the company-level characteristics of gearing, cash flow and liquidity. However, these terms were individually and jointly insignificant at the 5% level. Attempting to identify such non-linear effects at the company level may be asking too much of the data. For example, the aggregate analysis poses the question of whether changes in capital gearing over time have the same effect on the implicit interest rate, independent of the initial level of gearing. At the company level most of the variation in the data is between companies, the fixed effects estimator operates by exploiting time series variation for the individual companies. Differences in capital gearing between companies might reflect sectoral characteristics—for example, higher gearing is likely in industries with long gestation periods to finance investment. We consider the confirmation of effects from balance sheet and cash flow measures on the implicit interest rate at the individual company-level to be the key contribution of this analysis of company-level data.

Table C

Company-level implicit interest rates

	Implicit rate		Debt-smoothed implicit rate	
	[1]	[2]	[3]	[4]
	One-step	Two-step	One-step	Two-step
$R_{it\text{-}1}$	0.183 (0.017)	0.186 (0.009)		
$R^{adj}_{it\text{-}1}$			0.439 (0.021)	0.434 (0.008)
$(CF/K)_{it}$	-0.024 (0.012)	-0.020 (0.003)	-0.058 (0.013)	-0.061 (0.003)
$(CF/K)_{it\text{-}1}$	0.018 (0.009)	0.019 (0.003)	0.026 (0.010)	0.028 (0.003)
$(B/K)_{it}$	-0.008 (0.007)	-0.007 (0.002)	0.017 (0.006)	0.016 (0.002)
$(B/K)_{it\text{-}1}$	0.010 (0.006)	0.010 (0.001)	0.001 (0.004)	0.001 (0.001)
$(C^{Tot}/K)_{it}$	-0.004 (0.007)	-0.004 (0.002)	-0.013 (0.006)	-0.014 (0.001)
$(C^{Tot}/K)_{it\text{-}1}$	-0.007 (0.006)	-0.007 (0.001)	0.001 (0.005)	0.002 (0.001)
y_{it}	-0.016 (0.012)	-0.017 (0.005)	0.024 (0.010)	0.021 (0.003)
$y_{it\text{-}1}$	0.014 (0.013)	0.016 (0.005)	-0.025 (0.010)	-0.023 (0.003)
Year effects	Yes	Yes	Yes	Yes
Instruments	t-2..t-5; Δt-1	t-2..t-5; Δt-1	t-2..t-5; Δt-1	t-2..t-5; Δt-1
M_2	3.55 [0.00]	3.18 [0.00]	-0.56 [0.58]	-0.66 [0.51]
Companies	2,055	2,055	1,469	1,469
Observations	17,503	17,503	12,564	12,564

Note: Estimation by GMM-System estimator using the robust one-step method and two-step methods as indicated (Blundell and Bond (1998); Arellano and Bond (1991)). Sargan is a test (p-value) of overidentifying restrictions. This is only available under the two-step estimates (the one-step estimates report this value). M_2 is a test of second-order serial correlation in the first-differenced residuals, asymptotically distributed $N(0,1)$, p-value in parentheses. Robust standard errors reported in parentheses. Instruments as stated. The 'debt-smoothed' implicit rate is the ratio of interest payments in the year to a three-year moving average debt figure, centred on the particular year.

The estimates from the company account estimation in Table C may also be used to derive the implied change in the cost of debt for a company for a given change in cash flow, debt or total cash in both the short run and long run. These are reported in Table D. A 10 percentage point increase in cash flow reduces the implicit interest rate by almost half a percentage point, while an increase in debt of 10 percentage points increases the implicit rate by 18 basis points in the short run and by 31 basis points in the long run. The effects from cash assets are of a similar magnitude working in the opposite direction.

Table D
Effects of financial characteristics on implicit interest rates (percentage points (pp))

	Short run	Long run
10 pp increase in cash flow	-0.49	-0.42
10 pp increase in debt	0.18	0.31
10 pp increase in cash assets	-0.13	0.21

Note: The table indicates the implied change in the implicit interest rate in percentage points for a 10 percentage point increase in each of the regressors in both the short run and long run. Based on estimates in Table C, column 4.

4. Simulation results

What quantitative role might the finance premium play in the propagation of shocks? This is among the key implications of the finance premium that we wish to consider. In the light of this, in this section we describe the potential role of the aggregate model of the finance premium when included in a macroeconomic model. For this purpose we use the Bank of England's macroeconometric model, extended to derive estimates of corporate balance sheets.(11) We have deliberately chosen shocks that may have a significant effect on factors driving the external finance premium over a short-run horizon (up to two years). This is because

(a) changes in indebtedness and capital gearing take some time to build up in the face of shocks to flows; and
(b) in turn changes in capital gearing take some time to work through to changes in the external finance premium.

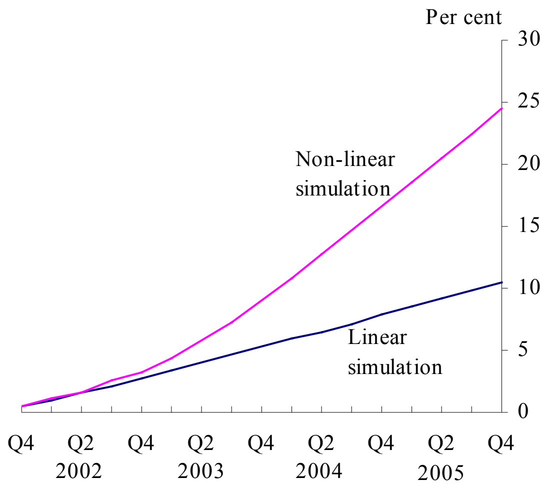
The two shocks considered are:
(i) A fall in net equity finance.
(ii) A temporary rise in official interest rates.

The first simulation describes a situation where, for some unspecified reason, a weakening in conditions in the equity market causes firms to rely more on debt finance. This shock is clearly not a pure 'exogenous' shock, but is designed to show the potential consequences of including the external finance channel. The shock to net equity finance is assumed to be around £8 billion, roughly the level of external finance in 2001 Q3. Policy interest rates are held constant. The transmission mechanism is as follows. The fall in equity finance raises recourse to debt for a given level of external finance. This leads to a rise in interest payments, and increases the probability of default based on the part of the model determining corporate liquidations (through

(11) See Benito, Whitley and Young (2001).

higher capital gearing). Some feedback to increased financial fragility is assumed with firms partially reducing dividends when profits net of interest costs fall. But the remaining interest costs cumulate into outstanding debt without any further corrective action by firms, resulting in a potential debt spiral. The presence of a credit channel accentuates this mechanism by making the corporate interest rate depend directly on the level of debt. The implications of the shock for corporate liquidations are shown in Chart 7. The response of the implicit interest rate, and hence of liquidations differs, depending on whether gearing is above its average level prior to the shock (linear effect); or whether gearing is just below its threshold level before the shock with the shock raising it above this level (non-linear effect). In the first case, corporate liquidations rise steadily by over 10% after four years without any corrective action by firms, but this more than doubles when the non-linear effect is triggered. Implicit interest rates rise by over 3 percentage points in the non-linear case.

Chart 7
Effects of fall in net equity on corporate liquidations



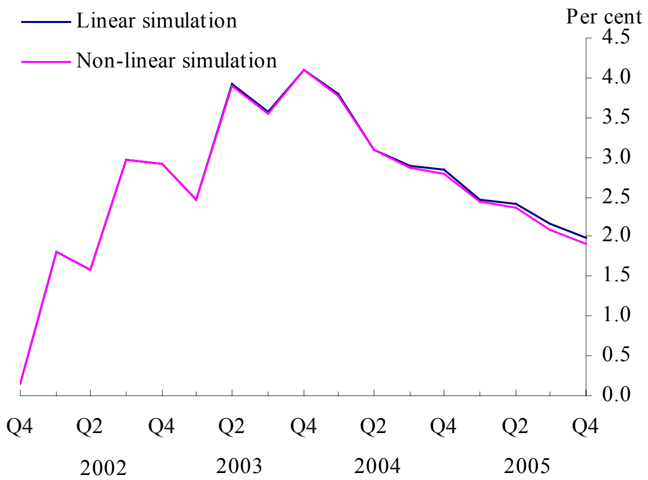
Source: Bank calculations.

Note: Percent changes from base.

The second shock is an unanticipated rise in official interest rates by 1 percentage point for one year. In the absence of an external finance premium implicit corporate rates are assumed to rise by around 0.6 percentage points. Here the rise in official interest rates affects corporate income and profitability through macroeconomic feedbacks. In contrast the additional spread for the corporate sector affects interest payments, and hence income gearing. The results of the simulation on corporate liquidations are shown in Chart 8. In contrast to the net equity simulation there is little sensitivity to the non-linear effect when the initial shock is from policy interest rates. This largely reflects the temporary nature of the shock to interest rates, as it is changes in these policy rates, rather than the effect on indebtedness that drives implicit corporate interest rates.

The simulations show that the transmission effects depend not only on the initial level of capital gearing (state of corporate balance sheets) but also on the source of any shock. In general the potential for unstable debt build up is increased by the inclusion of the external finance channel but these simulations do not include strong corrective actions by firms in the face of these shocks as the extended macroeconomic model does not yet include corporate sector balance sheet adjustment. This limits the usefulness of the simulations in describing the possible overall impact of changes in financial conditions on real variables, although it does help to isolate the potential contribution of the external finance channel. Further work is aimed at incorporating balance sheet adjustment, thereby limiting the potential for unstable debt build-up in simulations of this type (see, for example, empirical analysis of balance sheet adjustment at the firm level by Benito and Young (2002)).

Chart 8
Effects of rise in short-term interest rates on corporate liquidations



Source: Bank calculations.

Note: Percent changes from base.

5. Conclusions

Credit channel models consider how changes in the financial positions of borrowers and lenders can shape how interest rates affect the economy. In particular, they generate a role for financial factors to influence the transmission of shocks throughout the economy by influencing the external finance premium.

This paper has considered an intermediate implication of such a framework. More specifically, the analysis presented has described the construction of both aggregate and individual company-level measures of the implicit interest rate faced by firms. By relating these to measures of risk-free rates and corporate indebtedness, the analysis has isolated a role for the external finance premium. Somewhat unusually, this analysis has been carried out at both the level of the aggregate UK non-financial corporate sector using national accounts and individual firm level using company accounts data.

The empirical aggregate model that relates the measured implicit interest rate to corporate indebtedness, together with measures of risk-free rates, implies long lags between changes in measures of indebtedness and corporate spreads. It also supports a non-linear effect from capital gearing. That is, gearing is only important when the level of indebtedness is relatively high. In order to trace through the likely implications for the macroeconomy of this external finance premium story in the propagation of shocks, simulations have been presented using a version of the Bank's macroeconomic model extended to include the balance sheets of the corporate sector.

In these simulations, the role of the finance premium is not particularly marked in the short run, since shocks take some time to raise capital gearing, and changes in gearing, in turn, take some time to be reflected in higher spreads. But the implications are more important over the longer term, and imply that firms might need to take more corrective action to stabilise debt and avoid default than would be the case if there were no external finance premium. The nature of these adjustment mechanisms is worthy of further research effort.

Appendix A

The maturity composition of corporate debt in the national accounts

We define corporate short-term debt as short-term loans plus short-term commercial paper. The national accounts break down the loans of private non-financial corporations into short-term and long-term loans.

Short-term loans include sterling loans by UK financial institutions; foreign currency loans by UK financial institutions and loans by non-resident UK financial institutions. They account for around 95% of short-term debt and around 60% of total debt (excluding direct investment) in 2000. Commercial paper and local authority bills account for the remaining 5% of short-term debt. However lending does include some unspecified loans of more than one-year original term.

Within the total of short-term loans, sterling loans by UK financial institutions accounted for 57% in 2000 and sterling loans by building societies a further 2%.

Foreign currency loans are UK banks and building society loans denominated in foreign currency. Some loans of greater than one year may also be included. These loans accounted for around 13% of short-term corporate debt in 2000 with lending by rest of the world financial institutions a further 26%.

Long-term debt are defined as bonds, finance leasing loans, other loans by UK residents and other loans from the rest of the world. Bonds accounted for around 75% of long-term debt in 2000, with finance leasing a further 8% and other lending 17%.

Appendix B

Company-level data

The data are derived from company accounts records held on Thomson Financial Datastream. The construction of the variables used in the company-level analysis is as follows. (Datastream Item numbers in parentheses.)

Implicit interest rate
Total interest charges (DS153) divided by total company debt (DS309+DS321).

Cash flow
Net income (DS182) plus depreciation of fixed assets (DS136).

Debt
Total loan capital repayable in more than one year (DS321) plus borrowings repayable in less than one year.

Liquid assets
Total cash and equivalent assets (DS375).

Capital stock
Capital stock is measured on a replacement cost basis. The procedure employed uses a perpetual inventory method as has been used in a number of company accounts panel data studies (eg Blundell *et al* (1992)). A rate of depreciation of 0.08 is assumed. For the company's first observation, the replacement cost is assumed equal to the historic cost total net fixed assets (DS339), adjusted for inflation.

Company sales
Total company sales (DS104).

Appendix C
Outlying interest rates from company accounts data

Table C1
High outlying implicit interest rates

Company	Year	Implicit interest rate (pp)	Interest payments (£000)	Borrowing repayable within 1 year (£000)	Borrowing repayable after 1 year (£000)
1	1996	0.105	883	3,580	4,856
	1997	0.097	819	5,184	3,219
	1998	0.102	1,055	8,291	2,044
	1999	*0.479*	*979*	*1,442*	*603*
2	1977	0.058	180	2,962	165
	1978	0.083	300	3,437	164
	1979	*0.429*	*349*	*679*	*134*
	1980	0.226	406	1,671	129
	1981	0.334	332	866	129
3	1979	0.114	293	2,449	111
	1980	0.184	308	1,563	108
	1981	*0.460*	*462*	*824*	*180*
	1982	0.253	382	1,388	123
	1983	0.097	197	1,906	116
4	1977	0.106	476	4,470	0
	1978	0.082	522	6,398	0
	1979	*0.444*	*988*	*2,223*	*0*
	1980	0.115	775	6,721	0
	1981	0.119	1,018	8,559	0

Table C2
Low outlying implicit interest rates

Company	Year	Implicit interest rate (pp)	Interest payments (£000)	Borrowing repayable within 1 year (£000)	Borrowing repayable after 1 year (£000)
1	1994	0.103	114	0	1,108
	1995	*0.008*	*234*	*571*	*28,378*
	1996	0.115	2,459	276	21,082
	1997	0.088	1,870	4,359	16,898
	1998	0.095	1,679	5,519	12,187
	1999	0.114	1,624	6,150	8,055
2	1974	0.030	8	168	98
	1975	0.026	6	156	71
	1976	*0.011*	*4*	*324*	*45*
	1977	0.058	19	310	18
	1978	0.025	11	437	2
	1979	0.070	66	949	0
3	1973	0.017	11	434	201
	1974	*0.009*	*9*	*739*	*269*
	1975	0.025	25	226	760
	1976	0.157	237	405	1,105
	1977	0.151	236	677	887
4	1973	0.127	61	0	482
	1974	*0.009*	*45*	*0*	*5,218*
	1975	0.152	512	0	3,363
	1976	0.031	245	48	7,984
	1977	0.085	628	1	7,410

Source: Thomson Financial Datastream.

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