Testing for Inconsistencies in the Estimation of UK Capital Structure Determinants

Alan A. Bevan[♣] and Jo Danbolt[♦*]

[♣] European Bank for Reconstruction and Development, Office of the Chief Economist, EBRD, One Exchange Square, London EC2A 2JN, UK, and Centre for New and Emerging Markets, London Business School.

[♦]University of Glasgow, Department of Accounting and Finance, 65-73 Southpark Avenue, Glasgow G12 8LE, UK.

Abstract

We analyse the determinants of the capital structure of 1,054 UK companies from 1991 to 1997, and the extent to which the influence of these determinants are affected by time-invariant firm-specific heterogeneity. Comparing the results of pooled OLS and fixed effects panel estimation, we find significant differences in the results. While our OLS results are generally consistent with prior literature, the results of our fixed effects panel estimation contradict many of the traditional theories of the determinants of corporate financial structure. This suggests that results of traditional studies may be biased owing to a failure to control for firm-specific, time-invariant heterogeneity. The results of our fixed effects panel estimation find larger companies to have higher levels of both long-term and short-term debt than do smaller firms; profitability to be negatively correlated with the level of gearing, although profitable firms tend to have more short-term bank borrowing than less profitable firms, and tangibility to positively influence the level of short-term bank borrowing, as well as all long-term debt elements. However, the level of growth opportunities appears to have little influence on the level of gearing, other than short-term bank borrowing, where a significant negative relationship is observed.

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* Corresponding author. E-mail: J.Danbolt@accfin.gla.ac.uk; Tel: +44 (0)141 330 6289; Fax: +44 (0)141 330 4442.

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I. Introduction

The corporate finance literature contains a host of papers examining the nature, and determinants, of corporate financial structure. While in general the literature has succeeded in establishing some stylised facts relating the debt-equity decision to a variety of independent variables, it has largely done so using observations drawn from a single period. In this paper, we analyse capital structure and its determinants for a panel of 1,054 listed UK companies over the time period from 1991 to 1997, giving a total of 6,001 firm-year observations. The use of panel data not only improves sample size relative to single-period cross-sectional analysis, but is also better able to capture effects than either cross-sectional or time-series data alone (Hsiao, 1986; Baltagi, 1995).

We base our analysis on pooled ordinary least squares (OLS) and fixed effects panel estimation. OLS estimation — while common in this literature — may be biased, owing to a failure to control for time-invariant firm-specific heterogeneity. We therefore seek to explicitly test whether prior conclusions regarding the relationship between gearing and our independent variables hold once firm-specific, time-invariant heterogeneity is controlled for, a factor that has so far received limited attention in the capital structure literature.

Prior research for the UK has indicated that both the level of gearing (Rajan and Zingales, 1995; Bevan and Danbolt, 2002) and the determinants of gearing (Chittenden et al., 1996; Michaelas et al., 1999; Bevan and Danbolt, 2002) vary significantly

depending on the definition of gearing adopted. Consequently, in this paper, we base the analysis on various components of debt, rather than on more aggregate gearing measures. This rationale is lent support by the fact that while the overall level of indebtedness of our sampled firms has remained fairly stable, the relative importance of the various components of debt have changed considerably over time.

The results of our pooled OLS analysis are generally consistent with those of existing cross-sectional analyses for the UK. However, many of these results are overturned under fixed effects panel analysis, highlighting the importance of controlling for fixed effects in studies of corporate financial structure.

Our fixed effects estimation finds the level of the various debt components for the 1991-1997 period (all scaled by the book value of total assets) to be significantly related to: company size, with large companies tending to have higher levels of all forms of debt other than short-term securitised debt than smaller companies; the level of profitability, which is negatively related to all forms of debt except short-term bank borrowing, where there is a significant positive correlation, and the proportion of fixed to total assets ("tangibility") of the firm, which is positively correlated with all forms of long-term debt and short-term bank borrowing, but insignificantly related to other short-term debt elements. However, gearing appears not to vary significantly with the level of growth opportunities, save for a negative relationship with short-term bank borrowing.

The remainder of the paper is organised as follows: Section II firstly presents our null hypotheses based upon the key prior literature on the relationship between gearing and each of our four independent variables. We then consider alternative empirical findings

in the few studies that control for firm-specific heterogeneity. In section III we explain our dataset and methodology, while the results of our pooled OLS and fixed effects panel estimation are reported in section IV. Section V summarises and concludes.

II. Literature and Hypotheses

As argued by Titman and Wessels (1988) and Harris and Raviv (1991), the choice of explanatory variables in the analysis of cross-sectional variation in capital structure is fraught with difficulty. Following Rajan and Zingales (1995) and Bevan and Danbolt (2002), we adopt four key independent variables: the market-to-book ratio (as a proxy for growth opportunities); the natural logarithm of sales (as a proxy for company size); profitability, and tangibility (proxied by the ratio of fixed to total assets). The theoretical considerations and prior empirical evidence with regard to each of the independent variables are discussed below.

Growth Opportunities

Myers (1977) argues that the potential for under-investment or diversion of resources is most severe for companies whose value is predominately accounted for by future investment opportunities rather than by assets in place. Lenders may be reluctant to provide finance to such firms, although Myers (1977), Barnea et al., (1981), Stohs and Mauer (1996), Barclay and Smith (1996, 1999), Michaelas et al., (1999) and Ozkan (2000) argue that the relationship between growth opportunities and gearing may be different for short and long-term forms of debt, and that the agency problem may be mitigated if the firm issues short-term rather than long-term debt.

Consistent with these predictions, Titman and Wessels (1988), Chung (1993), Rajan and Zingales (1995), Barclay and Smith (1996) and Chen et al., (1997) all find a

negative relationship between growth opportunities and the level of either long-term or total debt. These results are robust to the method of estimation[1] and the country under study. However, while Bevan and Danbolt (2002) find a negative correlation between gearing and long-term debt, they find total gearing to be positively related to the level of growth opportunities.

Bevan and Danbolt (2002) find short-term debt to be positively related to growth opportunities, while Stohs and Mauer (1996) and Barclay and Smith (1996) find growth firms to have lower levels of all debt types, irrespective of maturity or priority. Thus, the evidence of the impact of growth opportunities on the cross-sectional variation in corporate gearing is rather mixed. However, based on the theoretical considerations and the majority of the prior empirical evidence, we make the following hypotheses:

H1: The levels of long-term debt components are negatively related to the level of growth opportunities.

H2: The levels of short-term debt components are positively related to the level of growth opportunities.

Size

Rajan and Zingales (1995, p. 1451) argue that "Larger firms tend to be more diversified and fail less often, so size … may be an inverse proxy for the probability of bankruptcy". Conversely, Smith and Warner (1979) and Michaelas et al., (1999) argue that the agency conflict between shareholders and lenders may be particularly severe for small companies. Lenders can manage the risk of lending to small companies by restricting the length of maturity offered. Small companies can therefore be expected

[1] For example Chen et al., (1997) and Bevan and Danbolt (2002) use OLS; Rajan and Zingales (1995) and Bevan and Banbolt (2002) use censored Tobit, while Titman and Wessels (1988) apply maximum likelihood linear structural relationship estimation. Barclay and Smith (1996) do not specify the estimation technique used. We return to this issue below.

to have less long-term debt — but possibly more short-term debt — than larger companies (Barnea et al., 1980; Whited, 1982; Titman and Wessels, 1988; Stohs and Mauer, 1996).

Once again, however, the empirical evidence is inconclusive. At the aggregate level, Crutchley and Hanson (1989), Bennett and Donnelly (1993), Rajan and Zingales (1995), Barclay and Smith (1996), and Bevan and Danbolt (2002) find a significant positive correlation between company size and gearing, while Marsh (1982) observes that debt issues are positively correlated with company size. However, Remmers et al., (1974) find no size effect and Kester (1986) reports an insignificant negative correlation between gearing and company size. Barclay and Smith (1996), Stohs and Mauer (1996), Demirguc-Kunt and Maksimovic (1999) all find debt maturity to be positively correlated with company size. However, Bevan and Danbolt (2002) find the relationship between company size and gearing to depend significantly on the specific debt element analysed: large companies tend to use more long-term debt, trade credit and short-term securitised debt, but less short-term bank financing than smaller companies. Despite some contradictory evidence, the weight of available empirical evidence finds debt maturity to be positively correlated with company size.

We therefore hypothesise:

H3: *The levels of long-term debt components are positively related to company size.*

H4: *The levels of short-term debt components are negatively related to company size.*

Profitability

Extending the analysis from the capital structure irrelevancy propositions of their 1958 paper, Modigliani and Miller (1963) argue that, due to the tax deductibility of interest payments, companies may prefer debt to equity. This would suggest that highly profitable firms would choose to have high levels of debt in order to obtain attractive tax shields. However, DeAngelo and Masulis (1980) argue that interest tax shields may be unimportant to companies with other tax shields, such as depreciation[2].

Alternatively, Myers (1984) and Myers and Majluf (1984) predict that, as a result of asymmetric information, companies will prefer internal to external capital sources. Thus a pecking-order is established, whereby companies with high levels of profits tend to finance investments with retained earnings rather than by the raising of debt finance. Consistent with this theory, Toy et al., (1974), Kester (1986), Titman and Wessels (1988), Bennett and Donnelly (1993), Rajan and Zingales (1995), and Bevan and Danbolt (2002) all find gearing to be negatively related to the level of profitability. Consequently, we hypothesise:

H5: The level of gearing is negatively related to the level of profitability.

Tangibility

Due to the conflict of interest between debt providers and shareholders (Jensen and Mekling, 1976), lenders face the risk of adverse selection and moral hazard. Consequently, lenders may demand security, and collateral value may be a major determinant of the level of debt finance available to companies (Scott, 1977; Stiglitz and Weiss, 1981; Williamson, 1988; Harris and Raviv, 1990).

[2] Based on DeAngelo and Masulis' (1980) argument, one would expect companies with large amounts of depreciation to have relatively low levels of debt. If fixed assets proxy for the availability of such non-interest tax shields, DeAngelo and Masulis' theory would imply a negative correlation between tangibility and gearing, contrary to what is generally observed (see section on tangibility below). In their

Bradley et al., (1984), Titman and Wessels (1988), and Rajan and Zingales (1995) find a significant positive relationship between tangibility and total gearing, while Marsh (1982) and Walsh and Ryan (1997) find the probability of debt issues to be positively related to the fixed asset ratio. However, Chittenden et al., (1996) and Bevan and Danbolt (2002) find the relationship between tangibility and gearing to depend on the measure of debt applied. While these studies find tangibility to be positively correlated with long-term forms of debt, a negative correlation is observed for short-term debt elements. Similarly, Stohs and Mauer (1996) find debt maturity to be highly correlated with asset maturity, providing strong support for the maturity matching principle (Brealey and Myers (2000)). However, Bennett and Donnelly (1993) find a positive correlation between gearing and collateral value for total and short-term debt, but not for long-term debt.

Despite some inconsistency in the prior evidence, we hypothesise:

H6: The levels of long-term debt components are positively related to the level of tangibility.

H7: The levels of short-term debt components are negatively related to the level of tangibility.

Influence of Estimation Technique

The analyses considered in the preceding discussion utilise a variety of alternative estimation techniques and explanatory variables. However, despite these variations, many of these empirical analyses may be subject to biases owing to a failure to control for time–invariant but firm-specific effects. Failure to control for such heterogeneity entails that the disturbance term in a classical linear regression will incorporate time-

empirical analysis, Bradley et al., (1984) find no support for DeAngelo and Masulis' tax-based theory.

invariant omitted factors. Consequently, if these omitted factors are contemporaneously correlated with the included independent variables — as is the underlying assumption of the fixed effects model — parameter estimation will be rendered biased and inconsistent[3]. Hence, inferences based upon parameters estimated without controlling for firm heterogeneity may lead to inappropriate conclusions (Baltagi, 1995). By transforming the model to eliminate time-invariant effects that vary by enterprise, the parameters of the fixed effects model are BLUE under OLS estimation. It is therefore important to test whether prior conclusions regarding the relationship between gearing and our independent variables are robust, or whether the results change when firm-specific, time-invariant heterogeneity is controlled for.

Indeed, it is interesting to note that studies that have applied fixed effects estimation, or other forms of estimation which control for firm effects, at times obtain results that contradict some of the results of the studies discussed above, which do not control for time-invariant, firm-specific effects. For instance:

- **Size** — Berger et al., (1997) find the positive relationship between gearing and company size to hold regardless of whether the regressions are estimated using OLS, random effects or fixed effects panel estimation, and Lasfer (1995) and Ozkan (2000, 2001) – who control for firm heterogeneity through random effect and generalised method of moments (GMM) estimation respectively – obtain results similar to prior studies which have failed to control for such effects. However, van der Wijst and Thurik (1993) and Barclay et al., (1995) find their results to depend on whether the estimation is undertaken using OLS or fixed effects. Van der Wijst and Thurik find both short and long-term gearing to be positively related to

[3] The coefficient of correlation between the firm-specific error term and the matrix of independent

company size, although the regression coefficients are much smaller under fixed effects than OLS estimation, and no longer statistically significant. Barclay et al., find an even larger change in the coefficients, with the correlation between size and total gearing reversing polarity, from significantly negative under pooled OLS to significantly positive under fixed-effects panel estimation.

- **Tangibility** — van der Wijst and Thurik (1993) find these regression coefficients to be somewhat smaller in magnitude with fixed effects than with OLS estimation, although still significant for short and long-term debt. However, the tangibility coefficient is no longer significant for total debt when estimated using fixed effects. Berger et al., (1997) find the coefficient for the relationship between asset collateral value and total gearing to change from insignificantly positive using OLS, to highly significantly negative when estimated using fixed effects. However, similar to prior studies (such as e.g., Stohs and Mauer, 1996), Ozkan (2000) find debt maturity to be highly correlated with asset maturity, consistent with the hypotheses based on the extant literature.

However, as noted in the section on growth opportunities above, the prior literature suggests that the relationship between growth opportunities and gearing appears to be robust to the method of estimation. This also holds for studies controlling for fixed firm-effects: Barclay et al., (1995), Michaelas et al., (1999), Lasfer (1995) and Ozkan (2000, 2001) all obtain coefficients similar to those of analyses which do not control for firm-specific and time-invariant heterogeneity. Michaelas et al., (1999) find long-term and total debt to be positively related to the market-to-book (MTB) variable, and Berger et al., (1997) find changes in total gearing ratios to be positively related to the

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variables reported in table 2 (corr(ui, x)) provides an indication of the extent of this bias in each equation.

market-to-book ratio. In addition, Berger et al., (1997) find the significant negative relationship between profitability and gearing to be robust to whether the estimation is based on OLS or fixed effects, as does Ozkan (2001).

Hence, there does appear to be at least some evidence suggesting results will depend upon whether or not firm-specific, time-invariant heterogeneity is controlled for. The coefficients obtained in studies that have failed to control for such effects may be biased, and the conclusions drawn, unreliable. The literature that attempts to control for firm-specific fixed effects suggests that these effects are likely to manifest themselves through the relationship between gearing and both size and tangibility. Consequently, we test for the extent, and implications, of this bias in section IV, through comparison of the results obtained using pooled OLS and fixed effects estimation techniques on our sample of UK firms.

III. Data and Methodology

Our dataset is derived from Datastream and contains accounting information for all listed non-financial UK companies over the time period from 1991 to 1997. In order to mitigate survivorship bias, companies are included in the analysis even if data is not available for every year. Consequently, the number of observations in each year vary, with a total of 6,001 firm-year observations on 1,054 companies[4]. While our assembled data was relatively clean, outliers were identified. In order to eliminate these it was necessary to winsorise all dependent and independent variables at the 2½ percent level[5].

[4] The analysis was also undertaken on a balanced panel of 550 companies for which information was available in every year. The results for this balanced panel (not reported) are very similar to the results for the non-balanced panel reported below.
[5] For details on the winsorising process, see Tuckey (1962).

Previous studies have suggested that the level of gearing depends significantly on the definition of gearing applied. In this study we therefore concentrate on a variety of long and short-term debt components rather than on the more aggregate gearing measures. Following the methodology established by Bevan and Danbolt (2002), we decompose debt into a series of long and short-term elements. All gearing measures are scaled by the book value of total assets and their precise definitions and a discussion of their levels and time series patterns are presented in appendix I.

Following Rajan and Zingales (1995) and Bevan and Danbolt (2002), we analyse the determinants of capital structure with reference to four key corporate characteristics: the level of growth opportunities; company size; profitability, and tangibility. Precise definitions of the independent variables are presented in appendix II. Appendix II also discusses the key features of the independent variables and their time series patterns.

In order to isolate the analysis from the potential reverse causality which exists between the independent and dependent variables, most empirical studies of capital structure lag their independent variables, which are typically a smoothed series (see e.g., Titman and Wessels, 1988; Rajan and Zingales, 1995; Bevan and Danbolt, 2002) and we follow this technique here. Hence we define our independent variables as lagged three year averages[6]. Our estimated relationship is thus:

$$Gearing_{i,t} = f\left(MTB_{i,t-3}, Logsale_{i,t-3}, Profitability_{i,t-3}, Tangibility_{i,t-3}\right) \quad \textbf{(1)}$$

where gearing refers to each of the individual gearing measures (as specified in appendix I), *i* refers to the individual firms, *t* to the time period of the gearing measure

(measured at the accounting year end), and *t-3* to the average for the previous three years.

IV. Empirical Results

Table 1 presents the results of our pooled OLS regression analysis. At the aggregate level, we find that our regressions are highly significant, and we are able to reject the null hypothesis of joint insignificance of our coefficients at less than the one percent level. Analysis of the individual debt elements reveals a series of equations that are significant at less than the one percent level, although the R^2 measure differs significantly among them, from a low of 2.41 percent for short-term securitised debt, to a high of 19.57 percent for trade credit.

[INSERT TABLE 1 HERE]

The results of our fixed effects estimation are presented in table 2. Comparison of the results presented in tables 1 and 2 suggests that the explanatory power of the regressions are lower under fixed effects estimation than under pooled OLS, similar to the findings of Barclay et al., (1995) and Berger et al., (1997). The failure to control for firm effects when companies are included in the sample more than once — as in our sample — may cause "…a potential overstatement of the *t*-statistics in the pooled regressions." (Barclay et al., 1995, p. 14)[7]. Nevertheless, we continue to be able to reject joint insignificance of our coefficients at less than the one percent level in all cases other than our short-term securitised debt measure where the regression is

[6] We also performed the same regression analysis with non-averaged one year lags of the independent variables, with no significant change in the results.

[7] As Barclay et al (1995) note, the extent of this influence is exacerbated by the fact that gearing tends to be highly autoregressive. Hence, in such circumstances, a failure to control for time-invariant firm-specific factors will lead to an upwards bias in the significance of estimated coefficients under pooled OLS.

significant at the 10 percent level. Moreover, the computed Hausman statistics reject random effects in favour of our chosen fixed effects model.

[INSERT TABLE 2 HERE]

Market-to-Book

The pooled OLS results in table 1 uncover a positive correlation between the market-to-book ratio and total liabilities, indicating that firms with growth opportunities tend to hold more debt — a result which contradicts a great deal of the literature, but concurs with previous findings by Chittenden et al., (1996), Michaelas et al., (1999) and Bevan and Danbolt (2002). Our pooled OLS results illustrate that total long-term debt is also positively correlated with growth opportunities, while long-term bank borrowing and securitised debt are of a positive sign, but not significant. Hence, on the basis of pooled OLS estimation, there does not appear to be any bias against growth companies in the long-term debt markets, and we therefore reject hypothesis 1.

By contrast, we are unable to reject hypothesis 2 at the aggregate short-term debt level, as we find total current liabilities to be positively correlated with growth opportunities. However, as we further disaggregate short-term debt, we find that while trade credit and equivalent and short-term securitised debt are also positively correlated with market-to-book, short-term bank borrowing is negatively correlated. Consequently, we reject hypothesis 2 in this case and interpret this as indicating that banks are reluctant to extend short-term finance to companies with growth potential rather than proven assets in place.

However, comparing the coefficients of the pooled OLS and fixed effects models

illustrates that controlling for underlying time-invariant heterogeneity in our sample has a significant effect on our results. We find that the previous positive correlation between the market-to-book measure and both total debt and total long-term debt becomes insignificant under fixed effects estimation. Therefore, controlling for time-invariant heterogeneity eliminates the influence of growth opportunities upon these measures, while the influence upon long-term bank debt and securitised debt remain insignificant. Consequently, we again reject hypothesis 1, but for different reasons than previously.

Moreover, we find that the correlation between growth opportunities and total current liabilities reverses sign from pooled OLS to fixed effects estimation, becoming negative and significant, and leading to a rejection of hypothesis 2 in this case. This change of sign is reflected by changes in the coefficients at the sub-current liabilities level, with the coefficients upon trade credit and equivalent and short-term securitised debt becoming insignificant. Thus, once firm-effects are controlled for, the level of growth opportunities has very little impact in the level of gearing, with the exception that growth firms have significantly less short-term bank borrowing than companies with lower levels of growth opportunities. This finding is in contrast to existing literature which finds the influence of growth opportunities to be robust to the method of estimation.

Size

We find size to be positively correlated with total debt and all long-term debt elements under pooled OLS estimation — hence we fail to reject hypothesis 3. We are, however, able to reject hypothesis 4 at the level of total short-term debt, as we find size to be positively correlated with total current liabilities.

This result can be explained more readily by the results at a further level of disaggregation. The negative and significant correlation between short-term bank debt and size indicates that lenders do indeed appear to minimise the risk of lending to smaller companies by restricting loan maturity. Hence, while we reject hypothesis 4 at the aggregate short-term debt level, we fail to reject it in the case of short-term bank debt under pooled OLS estimation. Conversely, the positive and significant correlation between size and short-term securitised debt suggest that smaller companies are less able to issue paper. The positive correlation between size and trade credit and equivalent may reflect the fact that larger companies are more able to extract trade credit from suppliers, and/or that suppliers are more willing to extend trade credit to larger customers. This may result from large firms being perceived to have lower risk of default.

The influence of company size on each of our debt measures does not change substantially under our different estimation techniques, although as comparison of the results presented in tables 1 and 2 illustrates, there are some slight changes in the magnitude and significance of the coefficients. We thus again fail to reject hypothesis 3 and reject hypothesis 4 at the aggregate level, as under pooled OLS. Once again, however, short-term bank borrowing and securitised debt are exceptions: both of these coefficients change sign once we control for fixed effects, but while the size coefficient in the short-term securitised debt regression becomes insignificantly negative, that on short-term bank debt reverses sign and becomes positive and significant. Hence in these cases we find support for the finding of Barclay et al., (1995) that the correlation between size and debt reverses sign when the estimation technique is changed from pooled OLS to fixed effects. The missing variable bias of pooled OLS thus appears to

have some influence on the estimation of the relationship between gearing and company size. With the exception of short-term securitised debt and size, where the regression coefficient is negative and insignificant rather than positive and significant as under pooled OLS, we find a positive relationship between company size and all debt elements, including short term bank debt, once time-invariant heterogeneity is controlled for.

Profitability

Our pooled OLS results uncover a negative and significant correlation between profitability and all debt forms, and hence we are unable to reject hypothesis 5. Our results are thus consistent with the pecking-order theory, but contradict the tax shield hypothesis.

As the results presented in table 2 illustrate, although controlling for time-invariant heterogeneity leads to some slight changes in the magnitude and significance of the regression coefficients generally (most notably in the case of total current liabilities which loses significance), polarity remains constant save for short-term bank debt. The significant negative coefficients for profitability suggest that we are still unable to reject the pecking-order explanation for all debt forms other than short-term bank borrowing, where a significant positive regression coefficient is observed. Thus, similar to Berger et al., (1997), we find the method of estimation to have only marginal impact on the estimated relationship between gearing and profitability.

Tangibility

Finally, we are also unable to reject hypotheses 6 and 7 under pooled OLS estimation. We find tangibility to be positively correlated with all long-term debt elements and

negatively correlated with all types of short-term debt. Hence, we are able to support the collateral explanation in the case of long-term debt, and the maturity matching principle in the case of short-term debt. It is notable, however, that at the aggregate level total debt is found to be negatively correlated with tangibility, a result that confirms prior findings by Bevan and Danbolt (2002).

However, as do Berger et al., (1997), we find the influence of tangibility on the level of total debt to reverse sign when estimated using fixed effects rather than OLS. While Berger et al., find the impact of collateral value on total gearing to change from insignificantly positive with OLS to significantly negative with fixed effects, we find the tangibility coefficient changes from significantly negative under OLS to become positive and significant under the fixed effects model. The change in the sign of our coefficient from OLS to panel estimation is driven by the change of sign and loss of significance of total current liabilities. In turn, this change occurs as both trade credit and short-term securitised debt reverse sign and lose significance, and as the correlation between tangibility and short-term bank borrowing reverses sign to become positive and significant. Hence, once we control for time-invariant heterogeneity, we reject hypothesis 7, suggesting that collateral is not only correlated with the level of long-term debt, but is also a determining factor in obtaining short-term bank finance. Our results thus suggest that banks condition their lending — whether long-term or short-term — on the availability of collateral value. The positive tangibility coefficient for short-term bank borrowing contradicts the maturity matching principle.

The results of this section have therefore illustrated that controlling for underlying time-invariant heterogeneity through estimating a fixed effects model overturns several of the results obtained under OLS. As illustrated in Table 3, the estimated relationships

between short term debt and both the market-to-book and tangibility variables change significantly depending on whether the estimation is undertaken using pooled OLS or fixed effects panel estimation. There are also significant changes for individual debt components, highlighting the importance of basing the analysis on decomposed debt elements.

[INSERT TABLE 3]

Our analysis rejects hypothesis 1, and once we control for firm-specific time-invariant heterogeneity, we also reject hypothesis 2. Thus, contrary to expectations, we find that growth firms have less short-term but not long-term debt, than low market-to-book companies. Overall, the level of growth opportunities appear to have relatively little influence on the level of gearing.

While we fail to reject hypothesis 3 of a positive correlation between size and the level of long-term debt, we find large companies also to have more short-term debt than smaller companies, contrary to hypothesis 4. If we can regard size as an inverse proxy for the probability of bankruptcy, this suggests that default risk affects short-term as well as long-term lending decisions in our sample. Moreover, this finding, coupled with the fact that large firms have been found to have higher gearing levels *per se*, suggests that small firms are unable to utilise short-term finance to compensate for their restricted access to long-term debt financing.

Consistent with the pecking-order theory, and therefore hypothesis 5, we generally find a negative correlation between profitability and gearing. However, we observe a significant positive correlation between short-term bank borrowing and the level of

profitability once firm effects are controlled for. Although in a reduced form analysis such as ours it is not possible to separate out the demand and supply elements, one possible interpretation is that banks have conditioned the provision of short-term debt financing on the earnings capacity of the firm.

We do, however, also find short-term bank debt to be positively correlated with tangibility, contrary to the maturity–matching principle. While the results of our OLS and fixed effects estimation both support hypothesis 6, which predicted a positive correlation between tangibility and the level of long-term debt, there is no evidence of a negative relationship between tangibility and short-term debt in the fixed effects estimation. We therefore reject hypothesis 7. Instead our finding of a positive correlation between short-term bank debt and tangibility suggests that collateral may be equally important for short-term as for long-term debt, once we control for firm-specific fixed effects.

V. Summary and Conclusions

The literature on corporate financial structure has established a series of stylised facts relating the corporate debt-equity decision to a variety of independent variables. The majority of these stylised facts have, however, been established within the context of a single period framework. Moreover, many of the most influential studies have failed to control for firm-specific time-invariant heterogeneity, and hence have potentially suffered from inherent biases. Our analysis in this paper has therefore explicitly tested the influence of firm-specific fixed effects on corporate financial structure, through estimating pooled OLS and fixed effects models using the same panel dataset of non-financial UK firms for the period 1991 to 1997, and directly comparing the results of the alternative estimation techniques. Moreover, by conducting our analysis with

dependent variables based upon individual components of debt structure, we have mitigated the potential for bias induced by the choice of gearing measure.

While the results based on pooled OLS were found to generally support the conclusions from existing cross-sectional analysis, many of these conclusions were overturned under fixed effects estimation. Failure to control for firm effects may therefore introduce a serious bias into the analysis of corporate financial structure, and calls into question some of the conclusions drawn from more traditional analyses. In particular, our robust fixed effects model suggests the following relationships between debt and our four explanatory variables:

- The level of growth opportunities appears to have little influence on debt levels, save for a negative correlation with short-term bank borrowing. There is thus no indication that growth firms suffer relatively to other firms in terms of access to long-term debt finance;
- Company size is positively correlated with all debt elements, bar short-term securitised debt, where there is no relationship with size. Small firms thus appear to be unable to compensate for their restricted access to long-term debt financing by increased short-term borrowing;
- Profitability is negatively related to all debt elements, except for total current liabilities where we find no significant correlation, and short-term bank debt where we find a significant positive correlation. The latter result suggests that liquidity may be an important determinant of short-term bank financing,
- Tangibility is positively correlated with short-term bank borrowing, as well as all long-term debt elements. Collateral thus appears to influence all bank borrowing, whether short-term or long-term.

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Appendix I: Dependent Variable Definitions and Time Series Patterns

Our various gearing elements are defined as follows:

TLIABS	Total liabilities, which is the sum of total long term debt (TLTD) and total current liabilities (TCL);
TLTD	Total long term debt (repayable in more than one year), consisting of long term bank borrowing (BBGT1) and long term securitised debt (LTSD);
BBGT1	Bank borrowing repayable in more than one year;
LTSD	Long term securitised debt (non-bank borrowing repayable in more than one year);
TCL	Total current liabilities (repayable in less than one year), consisting of trade credit and equivalent (TTCE), bank borrowing repayable in less than one year (BBLT1), and short-term securitised debt (STSD);
TTCE	Total trade credit and equivalent;
BBLT1	Bank borrowing repayable in less than one year (including proportion of long term loans repayable within one year); and
STSD	Short-term securitised debt (non-bank borrowing repayable in less than one year).

Summary statistics for the various debt elements are contained in table A1. From this table it can be seen that the book value of total liabilities on average accounted for 49.41 percent of the book value of total assets in 1991. The vast majority of the liabilities are of a short-term nature, with only 17.36 percent of total liabilities (8.58 percent of total assets) accounted for by borrowing repayable in more than one year. From table A1, it can further be seen that trade credit and equivalent make up a significant proportion of company financing.

[INSERT TABLE A1 HERE]

Over the period from 1991 to 1997, the overall level of indebtedness of the average UK company has not changed significantly. However, there have been several significant changes in the relative importance of the various components of debt. This highlights the limitations of studies of capital structure based on more aggregate gearing measures. Over the period of analysis, there has been a statistically significant increase in the average level of long term debt, from 8.58 percent of total assets, to 9.72 percent. This increase was predominately accounted for by the (marginally significant) increase in the level of securitised debt, although a small increase in long term bank borrowing was also observed.

However, the increase in long-term forms of debt were more than offset by a general fall in the level of current liabilities, leading to a very small decline in the overall level of indebtedness. The overall fall in current liabilities of 1.64 percentage points is driven by a highly significant decline in the average level of short-term bank borrowing, from 8.49 percent of total assets to 5.34 percent. This is partly offset by a significant increase in the reliance on trade credit and other current liabilities.

Appendix II: Independent Variable Definitions and Time Series Patterns

Our various independent variables are defined as follows:

MTB Market-to-book ratio: the ratio of the book value of total assets (TA) less the book value of equity capital and reserves (ECR) plus the market value of equity (MV), to the book value of total assets (Equation A1);

$$MTB = \frac{TA - ECR + MV}{TA} \quad \text{(A1)}$$

LOGSALES The natural logarithm of sales (Equation A2);

$$LOGSALE = Ln(Sales) \quad \text{(A2)}$$

PROFITABILITY The ratio of earnings before interest, tax and depreciation (EBITDA), to the book value of total assets (Equation A3);

$$PROFITABILITY = \frac{EBITDA}{TA} \quad \text{(A3)}$$

TANGIBILITY The ratio of the book value of depreciated fixed assets (FA) to that of total assets (Equation A4);

$$TANGIBILITY = \frac{FA}{TA} \quad \text{(A4)}$$

Summary statistics for the explanatory variables are provided in table A2.

[INSERT TABLE A2 HERE]

On average, net (depreciated) fixed assets accounted for 35 percent of total assets in 1991 (based on the average for 1988-1990), a level not much different in 1997. Over the time period from the late 1980s to the mid 1990s, the average level of profitability fell from 16.02 percent to 13.08 percent. The mean level of turnover (expressed in 1996 values, adjusting nominal values by the GDP deflator (Stationery Office, 1998)) rose significantly from a mean of £63m for the time period 1988-1990 to £103m for 1994-1996. The market-to-book (MTB) value at 1.4618 for 1991 indicates that book values do not adequately reflect the value of UK companies. If book values provide fair estimates of replacement values or the value of assets in place, a market-to-book value substantially in excess of unity indicates that UK companies on average have valuable investment opportunities[8]. By the mid 1990s, the growth prospects of UK companies had improved, with the mean MTB value for 1997 (based on 1994-1996) of 1.5747.

[8] An MTB ratio in excess of unity does not unequivocally indicate that a company has valuable growth opportunities, as the MTB ratio will also exceed unity if the company has invested in positive NPV projects. However, while MTB may not directly measure growth opportunities, it provides a good proxy. Barclay and Smith (1999) find the MTB variable to produce results very similar to those obtained with other proxies for growth opportunities in cross-sectional regressions of capital structure. For a discussion of the measurement of growth opportunities, see Danbolt et al., (2002).

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Table 1
Pooled OLS Analysis of Determinants of Decomposed Debt Elements in the UK

	TLIABS	TLTD	BBGT1	LTSD	TCL	TTCE	BBLT1	STSD
Constant	0.3795***	-0.0937***	0.0141**	-0.1085***	0.4650***	0.2845***	0.1680***	0.0080***
	(0.0159)	(0.0088)	(0.0063)	(0.0057)	(0.0140)	(0.0119)	(0.0073)	(0.0027)
MTB	0.0385***	0.0060**	0.0022	0.0015	0.0327***	0.0329***	-0.0044**	0.0018***
	(0.0051)	(0.0026)	(0.0018)	(0.0014)	(0.0044)	(0.0036)	(0.0020)	(0.0007)
Logsales	0.0161***	0.0136***	0.0027***	0.0111***	0.0030***	0.0084***	-0.0061***	0.0007***
	(0.0013)	(0.0007)	(0.0005)	(0.0005)	(0.0011)	(0.0009)	(0.0005)	(0.0002)
Profit	-0.5221***	-0.1746***	-0.1052***	-0.0575***	-0.3268***	-0.0955***	-0.1470***	-0.0492***
	(0.0366)	(0.0178)	(0.0130)	(0.0106)	(0.0330)	(0.0253)	(0.0170)	(0.0062)
Tang	-0.1482***	0.1226***	0.0389***	0.0797***	-0.2765***	-0.2712***	-0.0167***	0.0092***
	(0.0117)	(0.0073)	(0.0053)	(0.0045)	(0.0105)	(0.0080)	(0.0056)	(0.0019)
R^2	0.0999	0.1273	0.0284	0.1590	0.1557	0.1957	0.0518	0.0241
F	132.35***	223.68***	38.88***	224.60***	226.44***	360.71***	73.69***	27.39***
N	6001	6001	6001	6001	6001	6001	6001	6001

*, ** and ***, significant at the 10, 5 and 1 percent level respectively, using a two-tailed t-test. All dependent and independent variables are scaled by total assets. TLIABS refers to total liabilities, which is defined as the sum of total long term debt and total current liabilities; TLTD refers to total long term debt (repayable in more than one year); BBGT1 refers to bank borrowing repayable in more than one year; LTSD refers to long term securitised debt; TCL refers to total current liabilities; TTCE refers to total trade credit and equivalent; BBLT1 refers to bank borrowing repayable in less than one year and STSD refers to short-term securitised debt. White-adjusted (White, 1980) standard errors are reported in parentheses.

Table 2
Fixed Effects Panel Analysis of Determinants of Decomposed Debt Elements in the UK

	TLIABS	TLTD	BBGT1	LTSD	TCL	TTCE	BBLT1	STSD
Constant	0.0419	-0.1319***	-0.0364	-0.0499**	0.1820***	0.1493***	-0.0251	0.0205*
	(0.0543)	(0.0365)	(0.0271)	(0.0220)	(0.0436)	(0.0344)	(0.0322)	(0.0108)
MTB	-0.0030	0.0029	0.0019	0.0002	-0.0076**	0.0008	-0.0155***	0.0001
	(0.0044)	(0.0030)	(0.0022)	(0.0018)	(0.0038)	(0.0028)	(0.0026)	(0.0009)
Logsales	0.0364***	0.0167***	0.0057**	0.0074***	0.0196***	0.0171***	0.0061**	-0.0001
	(0.0046)	(0.0031)	(0.0023)	(0.0019)	(0.0039)	(0.0029)	(0.0028)	(0.0009)
Profit	-0.0676**	-0.0411*	-0.0315*	-0.0230*	-0.0273	-0.1713***	0.1675***	-0.0178***
	(0.0333)	(0.0224)	(0.0166)	(0.0135)	(0.0284)	(0.0211)	(0.0198)	(0.0066)
Tang	0.1420***	0.0937***	0.0556***	0.0262**	0.0330	-0.0118	0.0594***	-0.0051
	(0.0259)	(0.0174)	(0.0129)	(0.0104)	(0.0220)	(0.0164)	(0.0153)	(0.0051)
R^2 within	0.0180	0.0113	0.0054	0.0046	0.0063	0.0187	0.0232	0.0017
R^2 betw.	0.0001	0.1453	0.0192	0.2038	0.0186	0.0055	0.0883	0.0101
R^2 overall	0.0011	0.1086	0.0171	0.1454	0.0091	0.0084	0.0290	0.0044
Corr (ui, x)	-0.4039	-0.0288	-0.1103	0.2157	-0.3398	-0.1441	-0.5168	-0.0010
F	22.71***	14.08***	6.66***	5.74***	7.84***	23.54***	29.32***	2.05*
Hausman specification test for fixed versus random effects panel estimation								
χ^2 (4)	215.87***	30.17***	17.54***	26.13***	225.09***	221.06***	204.09***	19.22***

*, ** and ***, significant at the 10, 5 and 1 percent level respectively, using a two-tailed t-test. All dependent and independent variables are scaled by total assets. TLIABS refers to total liabilities, which is defined as the sum of total long term debt and total current liabilities; TLTD refers to total long term debt (repayable in more than one year); BBGT1 refers to bank borrowing repayable in more than one year; LTSD refers to long term securitised debt; TCL refers to total current liabilities; TTCE refers to total trade credit and equivalent; BBLT1 refers to bank borrowing repayable in less than one year and STSD refers to short-term securitised debt. White-adjusted (White, 1980) standard errors are reported in parentheses.

Table 3
Comparison of Pooled OLS and Fixed Effects Estimation Results

Hypothesis	Correlation	Expected Sign	Test of Hypothesis	
			Pooled OLS	Fixed Effects
H1	MTB and LT debt	-ve	Reject	Reject (TLIABS and TLTD lose sig.)
H2	MTB and ST debt	+ve	Fail to Reject (Reject for BBLT1)	Reject for TCL and BBLT1 (TTCE and STSD loses sig.)
H3	Size and LT debt	+ve	Fail to Reject	Fail to Reject
H4	Size and ST debt	-ve	Reject (Fail to Reject for BBLT1)	Reject (BBLT1 and STSD become positive but STSD loses sig.)
H5	Profitability and all debt	-ve	Fail to Reject	Fail to Reject (Reject for BBLT1, TCL loses sig.)
H6	Tangibility and LT debt	+ve	Fail to Reject	Fail to Reject
H7	Tangibility and ST debt	-ve	Fail to Reject (Reject for STSD)	Reject (BBLT1 reverses sign to become positive, TCL and STSD also reverse sign, but lose sig., TTCE loses sig.)

TLIABS refers to total liabilities, which is defined as the sum of total long term debt and total current liabilities; TLTD refers to total long term debt (repayable in more than one year); BBGT1 refers to bank borrowing repayable in more than one year; LTSD refers to long term securitised debt; TCL refers to total current liabilities; TTCE refers to total trade credit and equivalent; BBLT1 refers to bank borrowing repayable in less than one year and STSD refers to short-term securitised debt.

Table A1
Descriptive Statistics – Debt Elements: Means (Medians)

	TLIABS	TLTD	BBGT1	LTSD	TCL	TTCE	BBLT1	STSD	Obs
1991	0.4941 (0.4900)	0.0858 (0.0569)	0.0472 (0.0036)	0.0373 (0.0096)	0.4077 (0.3890)	0.3074 (0.2918)	0.0849 (0.0518)	0.0144 (0.0045)	884
1992	0.4936 (0.4849)	0.0910 (0.0617)	0.0503 (0.0045)	0.0394 (0.0097)	0.4041 (0.3880)	0.3052 (0.2897)	0.0811 (0.0467)	0.0149 (0.0039)	925
1993	0.4862 (0.4705)	0.0867 (0.0574)	0.0436 (0.0018)	0.0426 (0.0087)	0.3971 (0.3846)	0.3090 (0.2959)	0.0685 (0.0341)	0.0154 (0.0038)	906
1994	0.4963 (0.4823)	0.0890 (0.0520)	0.0433 (0.0024)	0.0393 (0.0076)	0.4010 (0.3841)	0.3270 (0.3171)	0.0597 (0.0255)	0.0153 (0.0029)	831
1995	0.4989 (0.4963)	0.0908 (0.0658)	0.0463 (0.0050)	0.0421 (0.0094)	0.4075 (0.3943)	0.3252 (0.3142)	0.0616 (0.0324)	0.0173 (0.0036)	859
1996	0.4908 (0.4893)	0.0920 (0.0667)	0.0480 (0.0080)	0.0427 (0.0088)	0.3967 (0.3872)	0.3229 (0.3098)	0.0530 (0.0267)	0.0168 (0.0036)	843
1997	0.4894 (0.4825)	0.0972 (0.0715)	0.0518 (0.0082)	0.0430 (0.0091)	0.3913 (0.3798)	0.3201 (0.3101)	0.0534 (0.0254)	0.0143 (0.0038)	753
Difference (1991-97)	-0.0047	0.0114**	0.0046	0.0057*	-0.0164**	0.0127*	-0.0315***	-0.0001	

Note: All variables normalised by total assets. TLIABS refers to total liabilities, which is defined as the sum of total long term debt and total current liabilities; TLTD refers to total long term debt (repayable in more than one year); BBGT1 refers to bank borrowing repayable in more than one year; LTSD refers to long term securitised debt; TCL refers to total current liabilities; TTCE refers to total trade credit and equivalent; BBLT1 refers to bank borrowing repayable in less than one year and STSD refers to short-term securitised debt. Test for significance of change in means from 1991 to 1997 based on two sample difference in means t-test. *, ** and ***, significant at the 10, 5 and 1 percent level respectively.

Table A2

Descriptive Statistics – Explanatory Variables: Means (Medians)

Variable	MTB	Logsales	Earnings	Tangibility	Obs
1991	1.4617 (1.3191)	11.0512 (10.8788)	0.1602 (0.1607)	0.3500 (0.3204)	884
1992	1.3578 (1.2406)	11.1003 (10.9257)	0.1514 (0.1545)	0.3666 (0.3361)	925
1993	1.3156 (1.2053)	11.1469 (10.9224)	0.1390 (0.1438)	0.3771 (0.3454)	906
1994	1.4319 (1.2805)	11.2451 (11.0132)	0.1264 (0.1346)	0.3776 (0.3467)	831
1995	1.4964 (1.3290)	11.2548 (11.0636)	0.1214 (0.1284)	0.3642 (0.3280)	859
1966	1.5529 (1.3633)	11.3737 (11.1976)	0.1250 (0.1307)	0.3521 (0.3143)	843
1997	1.5747 (1.3764)	11.5471 (11.3785)	0.1308 (0.1344)	0.3522 (0.3091)	753
Difference 1991-97	0.1129***	0.4959***	-0.0294***	0.0022	

Note: MTB refers to the ratio of market value to book value of assets, Logsales to the natural logarithm of turnover, Earnings is defined as EBITDA/Total assets, and Tangibility refers to the ratio of net (depreciated) fixed assets to total. The explanatory variables are calculated as one year lagged three year averages. Thus, the 1991 values refer to the mean values for 1988-1990.