Debt, Incentives and Performance:

Evidence from UK Panel Data

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Debt, Incentives and Performance: Evidence from UK Panel Data[¤]

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Abstract

A large body of theoretical literature suggests that capital structure plays an important role as a managerial incentive mechanism. Cross-sectional empirical studies have identi…ed a positive e¤ect of leverage on expected performance (measured by Q) for …rms with low growth opportunities: this has been interpreted as supporting Jensen's free cash ‡ow hypothesis. However, this evidence does not take into account the endogeneity of capital structure decisions. We investigate how endogeneity a¤ects the results using instrumental variables and allowing for dynamics. The results of earlier studies are then re-interpreted in the light of our …ndings.

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1. Introduction

What determines …rms' capital structure decisions? What are the implications for …rm performance? These questions have attracted a great deal of attention in the theoretical literature on …rms' …nancial structure (see Harris and Raviv (1991) for an excellent survey, as well as Hart (1995) and Shleifer and Vishny (1997) for more recent discussions). Our paper examines the same questions empirically, in the light of existing theories and notably the agency literature which highlights the potential role of debt as a mechanism to mitigate con‡icts between management and shareholders (Jensen and Meckling (1976), Grossman and Hart (1982), Jensen (1986), Harris and Raviv (1990), Stulz (1990), Hart and Moore (1995), Zwiebel (1996)) [1].

We identify some key econometric problems which arise when translating such theories into an empirical model that can be estimated with available data. Our main contribution lies in the analysis of panel data, which enables us to deal with these econometric problems. In so doing, we are able to shed some light on the value of the underlying theoretical approach. At the same time, we show that results obtained in the existing empirical literature, which has largely overlooked the econometric issues we address, are not robust; the implications of these …ndings are then discussed.

The argument is essentially as follows. In most contributions to the agency literature, only …rms possessing certain characteristics will choose to use debt as a managerial incentive mechanism. For example, according to Jensen's free cash ‡ow hypothesis, debt may act as a valuable managerial incentive mechanism for …rms with large cash ‡ows and few growth opportunities, because it induces management to pay out cash in the future, instead of …nancing the consumption of perks, or investing in unpro…table projects yielding substantial private bene…ts. Building on Jensen's original insight, Zwiebel has investigated the circumstances in which partially-entrenched management may choose to issue debt as a way of committing not to invest in unpro…table empire-building projects, thereby deterring takeovers. In his model, debt has value as a commitment device for managers with lower-than-average ability, since these are the only ones that can be disciplined by a credible threat of being replaced in the event of default (bankruptcy). If it were possible to observe all the relevant "characteristics", such as growth opportunities and managerial ability, it would be straightforward to verify whether …rms' capital structure decisions and performance are consistent with the predictions of di¤erent theories. In practice however many of the relevant characteristics

[1] See also the security design literature, including Townsend (1979), Diamond (1984), Gale and Hellwig (1985), Chang (1987), Hart and Moore (1989, 1994), Bolton and Scharfstein (1990), Dewatripont and Tirole (1994), and Berkovitch and Israel (1996).

are not observed by the econometrician. The existing empirical literature has dealt with this difficulty in different ways.

McConnell and Servaes (1995) (henceforth MS) estimate cross-sectional regressions of Tobin's Q (representing expected firm performance) on a range of variables including debt. For each cross-section, they split the data into a "high-growth" and a "low-growth" sample, using either the firm's P/E ratio or its sales growth[2] as a proxy for future growth opportunities. In both cases they find that the coefficient on debt is positive and significant for the "low" sample, becoming negative and significant for the "high" sample. They interpret their findings as follows: firstly, the positive relation between Q and debt in the "low" sample is consistent with Jensen's hypothesis that (only) firms with low growth opportunities benefit from leverage for incentive reasons. Secondly, the negative relation between Q and debt in the "high" sample is consistent with Myers' (1977) hypothesis that 'too much' debt induces managers, acting in shareholders' interests, to forego positive net present value projects (the well-known "underinvestment" problem of debt financing).

The approach followed by MS, however, does not take into account the endogeneity of debt. This becomes important if there are firm characteristics, unobserved by the econometrician, which affect both the firm's choice of capital structure and its expected performance: for example, managerial ability and entrenchment (as in Zwiebel), market power, and intangible assets such as reputation (as in Dessí (1999)). The presence of such unobserved influences is likely to generate a degree of correlation between debt and the error term in a cross-sectional regression of Q, leading to biased estimates of the coefficient on debt.

The endogeneity problem has been noted in the literature. Agrawal and Knoeber (1996), again using cross-section data, have estimated a simultaneous equations system with equations for Q and each of seven "control mechanisms", including debt[3]. The control mechanisms are allowed to depend on each other and on Q, while Q in turn depends on all the control mechanisms. The main finding is that most of the control mechanisms, including debt, have no significant effect on Q: this is interpreted as being consistent with the hypothesis that different control mechanisms are chosen efficiently, in the light of both observed and unobserved characteristics. Agrawal and Knoeber's approach has the advantage that it explicitly addresses the endogeneity issue; however, it requires some ad hoc identification restrictions.

[2] Both sales growth forecasts and historic sales growth measures are employed; the main findings are unaffected by the choice of classification scheme.

[3] The other control mechanisms are: shareholdings of insiders, institutions, and large shareholders; use of outside directors; the managerial labour market; and the market for corporate control.

Our paper explores an alternative approach, using panel data. If the unobserved firm characteristics affecting capital structure decisions and expected performance are relatively stable over time, they can be treated as firm-specific fixed effects: we can then use panel data techniques to obtain consistent estimates of the coefficients of interest. This is the starting point for our paper. We begin by estimating panel regressions for debt and Q, for a large sample of UK firms over the period 1967-1989. Our first finding is that fixed effects are highly significant: thus unobserved firm characteristics are important determinants of both capital structure and expected performance. Debt has a highly significant positive coefficient in our Q equation even when fixed effects are allowed for. However, it is not clear that the endogeneity problem in the present context can be addressed simply by allowing for fixed effects. Some of the unobserved determinants of capital structure and performance are likely to change significantly over time: for example, firms may experience shocks to their investment opportunities, or changes in their market power. This will generate some correlation between debt and the error term in the Q equation, even when fixed effects are allowed for. We therefore go on to investigate how the results are affected when we instrument debt in the Q equation. Our second main finding is that instrumenting debt reduces but does not eliminate its significance: the debt coefficient remains positive and significant at the 5% level.

The results just outlined are derived from a static model of debt and Q. Yet if some of the unobserved determinants of debt and Q are serially correlated, such a model may be inappropriate. Possible examples are easy to find: a shock to investment opportunities will have an immediate effect, but given the lags involved in the investment process the effect will also exhibit some persistence. An important advantage of using panel data is that it allows us to investigate whether a static model is in fact appropriate. Our third main finding is that there are important dynamic effects in both equations, and allowing for these eliminates the significance of debt in the Q equation.

This is consistent with the hypothesis that debt is chosen as implied by agency theories, in the light of both observed and unobserved firm characteristics. On the other hand, the evidence on the main determinants of debt and Q; while broadly consistent with the agency approach, does not provide any strong support for it. Moreover, our finding that firms with lower growth opportunities tend to have less debt in their capital structure is the opposite of what might be expected if Jensen's free cash flow hypothesis were to hold. In this respect our conclusions differ considerably from those reached by MS, and are closer to those reached by Bernheim and Wantz (1995), and Yoon and Starks (1995) in a different context (dividend behaviour)[4].

[4] Bernheim and Wantz study the effect of dividend taxation on the "bang-for-the-buck",

Our paper is also related to Himmelberg, Hubbard and Palia (1999), who use panel data to study the link between managerial equity ownership and expected firm performance. They address the endogeneity issue by allowing for fixed effects and instrumenting managerial equity ownership in their Q regression: this is sufficient to eliminate its significance. The main difference with our paper in terms of econometric methodology is that they do not investigate dynamics. Dynamic debt equations, on the other hand, have been estimated in recent work (Sauvé and Scheuer (1999)) for a sample of French and German firms: their results are consistent with ours in finding that dynamic effects are important, while highlighting considerable differences in persistence across countries.

Our finding that dynamics matter for both debt and Q suggests that further empirical research on this is needed, using alternative sources of data; moreover, the results point to a promising avenue for further theoretical research, on the dynamic relationship between firms' capital structure decisions and performance.

The remainder of the paper is organised as follows. Section 2 discusses in more detail some key issues involved in analysing the relationship between capital structure and performance, and outlines our empirical approach. The data is described in section 3. Our results are presented in section 4; section 5 concludes.

2. The relationship between capital structure and performance

As noted in the introduction, there is a large theoretical literature which views capital structure as a managerial incentive mechanism and/or commitment device. In Zwiebel (1996), for example, managers choose to issue debt as a commitment to sufficient dynamic efficiency to deter takeovers. Efficiency here entails refraining from investing in unprofitable empire-building projects. Managers are assumed to be partially entrenched: outside of bankruptcy, they can only be removed (by takeover) if there is a sufficiently large gain to the raider. Bankruptcy is assumed to circumvent entrenchment: specifically, in the event of bankruptcy the manager will be replaced whenever his ability is lower than the expected ability of a replacement manager. In this setting, (only) managers with lower-than-average ability can be disciplined by the possibility of bankruptcy: these are the managers who can, and in equilibrium will, credibly commit not to invest in unprofitable projects by issuing debt; the extent to which they do so depends on the degree of entrenchment. The model has the following implications:

defined as the share price response per dollar of dividends, and obtain results inconsistent with their version of a managerial discipline/ free-cash-flow hypothesis. Yoon and Starks study the wealth effects surrounding dividend change announcements, and find little support for the free cash flow hypothesis.

- debt decreases with ability, holding entrenchment constant (debt loses its e¤ectiveness as a commitment device for higher-ability managers);
- debt decreases with entrenchment, holding ability constant (managers only commit if they are under su¢cient pressure to do so);
- expected performance decreases with entrenchment, holding ability constant (for given ability, the manager is under less pressure to commit).

The relationship between expected performance and ability, holding entrenchment constant, is less clear-cut. This is because there are two opposing e¤ects at work: higher ability means that there is a greater likelihood of the manager …nding and undertaking good (pro…table) projects, which has a positive e¤ect on expected performance. However, higher ability also reduces the e¤ectiveness of debt as a commitment device, so that the manager may be more inclined to invest in bad (unpro…table) projects if he cannot …nd a good investment opportunity.

If we substitute "growth opportunities" for "managerial ability" we can obtain similar empirical predictions from Jensen's free cash ‡ow hypothesis[5]. The reason is that managerial ability in Zwiebel's model is de…ned as the probability that, in each period, the manager will have a good new investment opportunity: in practice this is very close to the notion of "growth opportunities" employed by Jensen. Thus according to the free cash ‡ow hypothesis, debt is valuable for …rms with large cash ‡ows and few growth opportunities, because it commits managers to pay out cash in the future, thereby reducing the "free" cash ‡ow at their disposal for empire-building investments (and other expenditures which increase managerial private bene…ts at the expense of …rm pro…ts).

The preceding discussion illustrates some of the implications of agency theories, and highlights an important di¢culty that arises in translating these implications into testable hypotheses: some of the key determinants of capital structure choices and expected performance are either unobserved or only imperfectly observed by the econometrician. This is typically the case for managerial ability and entrenchment, and for growth opportunities, discussed above; it is also the case for market power, and intangible assets such as the value of the …rm's reputation.

With regard to managerial ability / growth opportunities, there are two types of proxy that might be used. Proxies that rely on price information, such as the P/E ratio, have the advantage of being forward-looking and re‡ecting information available to the market but not to the econometrician. However, they capture a variety of in‡uences, not just growth opportunities, which means results are not easy to interpret. Moreover, since the measure of expected performance typically used is Tobin's Q, de…ned as the market value of the …rm divided by its book value,

[5] One di¤erence is that expected performance is a positive function of growth opportunities.

all the influences which affect any price-based proxy also affect the dependent variable. When the proxy variable is used to divide the sample into "high-growth" and "low-growth" subsamples (MS), there is a problem of endogenous sample selection. The problem can be avoided by using proxies which are not forward-looking, such as recent growth rates or recent profitability, but these fail to capture the effect of recent and current changes in growth opportunities. Growth rates also have the disadvantage that they do not necessarily reflect profitable growth opportunities (the relevant ones for Jensen and Zwiebel); similarly profitability may be due to factors other than profitable growth opportunites (e.g. market power). Thus no proxies can adequately capture the effect of a firm's growth opportunities or managerial ability.

The econometric implications of this can be readily seen with reference to the following empirical model, which nests the one used by MS[6]:

$$D_{it} = \beta_1 x_{it} + \gamma z_{it} + f_i + u_{it} \tag{2.1}$$

$$Q_{it} = \alpha D_{it} + \beta_2 x_{it} + g_i + w_{it} \tag{2.2}$$

where D denotes debt (normalised by net assets), and x and z denote vectors of observable exogenous variables.

To the extent that some of the key influences on capital structure and expected performance are not captured by the available proxies, they will be captured by the error terms in equations (2.1) and (2.2). The error terms will therefore be correlated, generating biased estimates if the equations are estimated by OLS. This is the approach followed by MS, who use cross-section data to estimate versions of the Q equation (2.2) for a "high-growth" and a "low-growth" sample. In both cases they find that debt has a significant coefficient (positive for the low-growth subsample and negative for the high-growth subsample). However, the potential bias due to correlation of the error terms makes it difficult to interpret these findings.

For some of the relevant variables, it might be reasonable to assume that they are relatively stable over time: in this case they can be treated as firm-specific fixed effects, and equations (2.1) and (2.2) can be estimated using panel data techniques, yielding consistent estimates. It is difficult, however, to argue that a firm's growth opportunities are likely to be constant over time. This and other time-varying unobserved influences on capital structure and performance will tend to generate a degree of correlation between u_{it} and w_{it}, and hence between D_{it} and w_{it} in equation (2.2). Thus OLS estimation of (2.2), even allowing for fixed

[6] Specifically, MS use cross-section data to estimate versions of (2.2) without the fixed effect g_i.

effects, will give biased estimates and t-statistics because of the endogeneity of D_{it}.

Correct inference can be obtained by instrumental variable estimation. In this formulation valid instruments would be given by z_{it}. We implement this estimation by two-stage least squares

$$D_{it} = \beta_1 x_{it} + \gamma z_{it} + f_i + u_{it} \tag{2.3}$$

$$Q_{it} = \alpha \hat{D}_{it} + \beta_2 x_{it} + g_i + w_{it} \tag{2.4}$$

where $\hat{D}_{it} = \hat{\beta}_1 x_{it} + \hat{\gamma} z_{it} + \hat{f}_i$. Of course since the effectiveness of this procedure depends on the presence of z_{it} in (2.1) and the absence of z_{it} in (2.2), we shall have to take care that both these conditions are satisfied. The allocation of variables between x and z will depend on both theoretical and statistical criteria.

A further misspecification arises if there is serially correlated behaviour in the dependent variable. This could be due, for example, to the effect of serially correlated omitted variables (such as growth opportunities). In this situation we would specify the models as

$$D_{it} = \lambda D_{it-1} + \beta_1 x_{it} + \gamma z_{it} + f_i + u_{it} \tag{2.5}$$

$$Q_{it} = \rho Q_{it-1} + \alpha D_{it} + \beta_2 x_{it} + g_i + w_{it} \tag{2.6}$$

Estimation of the dynamic panel model is complicated by the fixed effects. We use Anderson-Hsiao instrumental variable techniques[7]. Taking first differences we have

$$\begin{aligned} \Delta D_{it} &= \lambda \Delta D_{it-1} + \beta_1 \Delta x_{it} + \gamma \Delta z_{it} + \Delta u_{it} \\ \Delta Q_{it} &= \rho \Delta Q_{it-1} + \alpha \Delta D_{it} + \beta_2 \Delta x_{it} + \Delta w_{it} \end{aligned}$$

We use instrumental variables for ΔD_{it} in the second regression and for the lagged dependent variable in both regressions. Instruments used are ΔD_{it-2}; Δx_{it-1} and Δz_{it-1} in the first equation and $\Delta Q_{it-2}, \Delta z_{it}$; ΔD_{it-2} and Δx_{it-1} in the second.

3. The data

Our data comes from two sources: the Cambridge/DTI Databank (CDB) and the London Share Price Database (LSPD). The CDB contains information from the

[7] For a detailed discussion of these see Baltagi (1995).

published annual accounts of a sample of UK companies[8] over the period 1948-1990. The design of the sample is not ideal, notably owing to several changes in the selection criteria during the 1960s and 1970s, which truncated the sample to exclude smaller companies (for details see Meeks, Wheeler and Whittington (1998)). Nevertheless, the CDB is a particularly valuable dataset because information was collected over a very long period: this makes it possible to construct variables which require a large number of lags, and to use dynamic panel data techniques, as in the present paper.

The CDB does not contain any information on market value, which is needed to derive Tobin's Q (defined here as market value of equity plus book value of debt, divided by book value of equity and debt). We obtained this, where feasible, from the LSPD; specifically, we used the market price data (for the last trading day in December of the current year) together with the reported number of shares (as of 1st January of the following year) to obtain market value at the end of the (calendar) year. Book values come instead from the CDB, and refer to the end of the accounting year. This will give rise to some inconsistency, since companies have discretion over when to end the accounting year. The definition of the accounting year used in the CDB is as follows: data on accounting year t includes all company-years ending between April of year t and April of year t + 1. In practice there is a lot of clustering: the end of December is the most popular date for ending the accounting year. For company-years ending in the third quarter of year t or the first quarter of year t + 1, however, there will obviously be a timing inaccuracy in our measure of Q. The alternative would be to obtain the market value for the date on which the accounting year ends, for each company-year. The problem with this procedure is that it does not permit the use of time dummies in the analysis (far too many would be needed, making the estimation impossible). This is potentially a serious drawback, because aggregate shocks to prices could not be controlled for. We therefore prefer to use market values at the end of each (calendar) year, which means we can use yearly dummies to control for aggregate effects.

The dataset obtained by merging the company accounts information from the CDB and the market value information from the LSPD is an unbalanced panel of 1635 firms. From this panel we select all observations (company-years) for which there exist at least 10 lags in the data. The lags are necessary for the construction of the volatility variable (see below), and for the estimation of dynamic models. Some further observations are removed because they do not contain data on key variables (employment and sales). We also exclude a few outliers with very small

[8] For a detailed description of the industrial make-up of the sample see Meeks, Wheeler and Whittington (1998). Notice in particular that it does not include firms from the financial or insurance sectors.

(less than 0.16) or very large (more than 6) Q values (these cuto¤s for Q are the ones used by MS). The …nal sample consists of 557 …rms over the period 1967-1989. We clearly need to check whether attrition is likely to introduce any biases. There are two forms of attrition t younger and smaller, and hence riskier. However, we can control for such effects more accurately as follows. The CDB contains data on total depreciation, which is calculated by assigning an estimated lifetime to each asset, and then assuming that the value of the asset depreciates by a given proportion each year during that lifetime. Thus young firms, as well as older firms that have been growing rapidly (acquiring new assets), will tend to have low values of total depreciation relative to the value of total assets: these are precisely the firms that might be expected to have greater growth opportunities, reflected in higher values of Q. By contrast, firms that have been growing slowly will have higher values of total depreciation relative to the value of total assets: these firms are likely to have fewer growth opportunities, and lower values of Q. Once we control for the ratio of total depreciation to total assets in our Q equations, the theoretical arguments for including either sales or cashflow volatility as further explanatory variables no longer seem persuasive.

We then check the econometric validity of our instruments. Table 2 reports results for the static model. The first thing to note is that the suggested instruments are jointly significant in the debt equation. Further a joint test that the coefficients on these variables are both zero in the Q regression is not rejected $(F(2, 4638) = 2.16)$. Together these imply that the instruments are valid.

In the dynamic formulation we need to instrument the lagged dependent variable in each equation, as well as the debt variable in the Q equation (for endogeneity reasons, as in the static formulation). We use $\Delta D_{it-2}, \Delta x_{it-1}$ and Δz_{it-1} as instruments for ΔD_{it-1} in the debt equation, and $\Delta Q_{it-2}, \Delta x_{it-1}$ as instruments for ΔQ_{it-1} in the Q equation. The debt variable ΔD_{it} is instrumented by Δz_{it} and ΔD_{it-2}. The results are presented in Table 4. The differencing involved in the use of Anderson-Hsiao has weakened the significance of one of the original instruments for debt (volatility), but this is compensated for by the power of the lags as instruments[10]. Again a test that the chosen instruments for debt (Δz_{it} and ΔD_{it-2}) have zero coefficients in the Q regression is not rejected $(F(3, 4796) = 0.45)$, implying that the instruments are valid.

To check whether our results are robust to the choice of proxy for growth opportunities, we repeat the estimations using average recent growth in sales instead of our depreciation variable. The results are presented in Tables 3 and 5. The conclusions regarding instrument acceptability are again accepted.

[10] In a regression of ΔD_{it} on $\Delta D_{it-2}, \Delta x_{it}$ and Δz_{it}, the estimated coefficients for the second lag of (differenced) debt is highly significant, with a t-statistic of 6.64.

4.2. Results: the static model

We begin by presenting the results for the static model estimated as a fixed effects two way error component model. Table 2 reports the estimated panel regression coefficients for the debt equation and for the Q equation in the first two columns. Leverage is positively related to firm size, cashflow volatility and collateral. The positive relationship with size and volatility is consistent with the agency approach, as discussed above. The collateral variable measures the ratio of tangible fixed assets plus stocks and work in progress, divided by total assets. Firms with a higher value of this ratio might be expected to find it easier to borrow, which can account for the positive coefficient. There is a strong negative relationship with current and lagged profitability (measured as the ratio of operating income to total assets). To the extent that realised profitability is correlated with profitable growth opportunities, and with managerial ability, this is also consistent with the agency approach. The negative relationship with depreciation (defined as total depreciation divided by total assets), on the other hand, is the opposite of what might have been predicted on the basis of Jensen's hypothesis, since it means that slow-growing firms tend to have less debt, rather than more. Overall, our findings on the determinants of capital structure are in line with those of previous studies[11]. The results for the Q equation are broadly as expected: Q is positively related to current and lagged profitability, and negatively related to depreciation (proxying for slow growth). The negative relationship with employment (log of the number of employees) may reflect industry-specific effects, which we are not able to control for separately within a firm-specific fixed effects model. The key thing to note is that the debt coefficient is positive and highly significant, even though we are controlling for unobserved firm heterogeneity through the fixed effects. Moreover, the coefficient remains positive and significant when we instrument debt, although the significance is reduced; the results are reported in the third column of Table 2. A Hausman test for endogeneity of debt in the Q regression based on the estimated coefficients for debt in the IV and OLS is just significant at the 5% level ($\chi^2_1 = 3.97$), which given the low power of Hausman tests we take as fairly strong confirming evidence of the endogeneity of this variable in the Q regression. In all regressions the individual fixed effects and the time fixed effects have an important role to play, emphasising the value of the panel data approach.

[11] See, among others, Bradley et al. (1984), Chaplinsky and Niehaus (1990), Friend and Hasbrouck (1988), Friend and Lang (1988), Gonedes et al. (1988), Long and Malitz (1985), Kester (1986), Kim and Sorensen (1986), Marsh (1982), Smith and Watts (1992), and Titman and Wessels (1988). Kim and Sorensen and Smith and Watts find, unlike us, that firms with greater growth opportunites have lower leverage.

Table 3 presents the results using average recent growth in sales as a proxy for growth opportunities rather than depreciation. The results are qualitatively similar to those in Table 2. In particular, growth in sales has a positive coefficient in both debt and Q regressions. Thus slow-growing firms tend to have lower levels of debt in their capital structure, and lower expected performance as measured by Q. This is consistent with the findings obtained using our depreciation variable as a proxy for growth opportunities. The main difference with Table 2 is that instrumenting for debt in the Q regression leads to a loss of significance of this variable, though in this case a Hausman test can accept exogeneity of debt in the Q regression ($\chi^2_1 = 0.14$); indicating that instrumenting may not be required.

The results from the Q equations would be consistent with the joint hypothesis that capital structure can have a beneficial impact on managerial incentives, and that not all firms choose value-maximising capital structures. However, this conclusion rests on the assumption that the underlying model generating the data is indeed static. We therefore turn to the estimation of the dynamic model.

4.3. Results: the dynamic model

Tables 4 and 5 report the corresponding results for the models of Tables 2 and 3 allowing for dynamics modelled by the inclusion of a lagged dependent variable. Estimation is by the Anderson-Hsiao first-difference instrumental variable technique. The key findings are two. Firstly, there is evidence of highly significant dynamic effects in the determination of both debt[12] and Q, validating our concern that a static model might not be appropriate. Secondly, introducing dynamics does not on its own eliminate the significance of debt in the Q equation (column 2), but allowing for both dynamics and endogeneity does (column 3)[13]. Moreover, this is not due to weak instruments for debt, since both firm size and the lags of debt are strongly correlated with current debt. The other results are broadly as expected, in terms of the sign and significance of the coefficients, except that volatility is no longer statistically significant in the debt equation, as noted earlier, while depreciation now has a positive coefficient in the Q equation. This last finding is surprising: in theory, it seems likely that once lagged Q is included as an explanatory variable, the depreciation variable will lose explanatory power,

[12] Results from dynamic debt equations for a panel of French and German firms over the period 1987-1995 are reported in Sauvé and Scheuer (1999). Broadly their results are quite similar to ours, although the implied speed of adjustment of capital structure is somewhat slower in Germany and markedly slower in France than in Tables 4 and 5.

[13] Note that Hausman tests are unavailable here since we have no efficient technique for estimation of a dynamic model, let alone a dynamic fixed effects panel formulation.

since lagged Q should be a better proxy for growth opportunities; however, there is no obvious reason for the change of sign[14]. On the other hand, the fact that the coe¢cient is no longer statistically signi…cant at the 5% level is consistent with what might be expected. Similarly in Table 5 the growth in sales variable is insigni…cant, as would be expected once lagged Q is included as an explanatory variable. The key result of Table 4 is repeated in Table 5 : the signi…cance of debt as a determinant of Q disappears when we allow for endogeneity and dynamics.

5. Conclusions

Agency models of capital structure point to a potentially very important role for debt in the provision of managerial incentives. Any attempt to quantify the signi…cance of such incentive e¤ects is fraught with di¢culty. Nevertheless, the existing empirical literature has identi…ed a strong positive e¤ect of leverage on expected …rm performance, measured by Tobin's Q, for "low-growth" …rms (MS), as predicted by Jensen's free cash‡ow hypothesis. The econometric methodology used to obtain this result does not take into account the endogeneity of capital structure decisions. Our paper has investigated the robustness of the result when endogeneity is explicitly accounted for. Unlike previous studies, we use panel data, which has two key advantages. Firstly, it allows us to control for unobserved …rm heterogeneity that is stable over time, through …rm-speci…c …xed e¤ects. Secondly, it makes it possible for us to analyse dynamic relationships.

Our results show that unobserved …rm heterogeneity, as re‡ected in the …xed e¤ects, is a highly signi…cant determinant of both leverage and Q, demonstrating the value of using panel data. Within a static framework, we …nd that leverage has a signi…cant positive e¤ect on Q, even when we include …xed e¤ects. Moreover, leverage remains statistically signi…cant when we instrument it to allow for endogeneity, using cash‡ow volatility and …rm size as instruments. However, when we go on to investigate a dynamic framework, we …nd evidence of highly signi…cant dynamic e¤ects in the determination of debt and Q, calling into question the use of a static framework. The dynamic e¤ects may well be due to the presence of unobserved in‡uences that are serially correlated and a¤ect both variables. The estimated coe¢cient for debt in the dynamic equation for Q is still positive and signi…cant when we do not instrument

Our findings demonstrate the importance of taking into account the endogeneity of capital structure decisions, and their dynamics. They suggest that existing empirical evidence which ignores the endogeneity issue and/or is based only on the estimation of static models should be treated with some caution. Moreover, they highlight a promising area for further research, namely the dynamic relationship between capital structure decisions and performance.

6. References

[1] Agrawal, A. & Knoeber, C. (1996) "Firm performance and mechanisms to control agency problems between managers and shareholders" Journal of Financial and Quantitative Analysis, 31(3), 377-397.

[2] Anderson,T.W. & Hsiao,C. (1982) "Formulation and Estimation of Dynamic Models using Panel Data" Journal of Econometrics, 18, 47-82.

[3] Baltagi, B.H. (1995) "Econometric Analysis of Panel Data", Wiley.

[4] Berkovitch, E. & R. Israel (1996) "The design of internal control and capital structure", Review of Financial Studies, 9, 208-240.

[5] Bernheim, B.D. & A. Wantz (1995) "A tax-based test of the dividend signaling hypothesis", American Economic Review, 85(3), 532-551.

[6] Bolton, P. & Scharfstein, D. (1990) "A theory of predation based on agency problems in …nancial contracting" American Economic Review, 80, 93-106.

[7] Bradley, M., Jarrell, G. & Han Kim, E. (1984) "On the existence of an optimal capital structure: theory and evidence" Journal of Finance, 39, 857-78.

[8] Chang, C. (1987) "Capital structure as optimal contracts" Working Paper, Carlson School of Management, University of Minnesota.

[9] Chaplinsky, S. & Niehaus, G. (1990) "The determinants of inside ownership and leverage" University of Michigan Working Paper.

[10] Dessí, R. (1999) "Implicit contracts, managerial incentives and …nancial structure", mimeo, London School of Economics.

[11] Dewatripont, M. & Tirole, J. (1994) "A theory of debt and equity: diversity of securities and manager-shareholder congruence" Quarterly Journal of Economics, 109, 1027-1054.

[12] Diamond, D. (1984) "Financial intermediation and delegated monitoring" Review of Economic Studies, 51, 393-414.

[13] Friend, I. & Hasbrouck, J. (1988) "Determinants of capital structure" in A. Chen (ed.) Research in Finance, vol VII, New York: JAI Press.

[14] Friend, I. & Lang, L. (1988) "An empirical test of the impact of managerial self-interest on corporate capital structure" Journal of Finance, 42, 809-22.

[15] Gale, D. & Hellwig, M. (1985) "Incentive compat

[18] Harris, M. & Raviv, A. (1991) "The theory of capital structure" Journal of Finance, 46, 297-355.

[19] Hart, O. (1995) Firms, Contracts, and Financial Structure. Oxford: Clarendon Press.

[20] Hart, O. & Moore, J. (1995) "Debt and seniority: an analysis of the role of hard claims in constraining management" American Economic Review, 567-585.

[21] Hart, O. & Moore, J. (1994) "A theory of debt based on the inalienability of human capital" Quarterly Journal of Economics, 109(41), 841-80.

[22] Hart, O. & Moore, J. (1989) "Default and renegotiation: a dynamic model of debt" Discussion Paper, University of Edinburgh.

[23] Himmelberg, C., Hubbard, G. & Palia, D. (1999) "Understanding the determinants of managerial ownership and the link between ownership and performance" Journal of Financial Economics, 53(3), 353-384.

[24] Jensen, M. (1986) "Agency costs of free cash ‡ow, corporate …nance and takeovers" American Economic Review, 76, 323-39.

[25] Jensen, M. & Meckling, W. (1976) "Theory of the …rm: managerial behavior, agency costs, and capital structure" Journal of Financial Economics, 3, 305-60.

[26] Kester, C. (1986) "Capital and ownership structure: a comparison of United States and Japanese manufacturing corporations" Financial Management, 15, 5-16.

[27] Kim, Y.C. & Sorensen, E. (1986) "Evidence on the impact of the agency costs of debt in corporate debt policy", Journal of Financial and Quantitative Analysis, 21, 131-44.

[28]Long, M. & Malitz, I. (1985) "The investment-…nancing nexus: some empirical evidence", Midland Corporate Finance Journal, 3, 53-9.

[29] Marsh, P. (1982) "The choice between equity and debt: an empirical study" Journal of Finance, 37, 121-44.

[30] McConnell, J. & Servaes, H. (1995) "Equity ownership and the two faces of debt", Journal of Financial Economics, 39, 131-157.

[31] Meeks, J., Wheeler, J. & Whittington, J. (1998) "The Cambridge/DTI databank of company accounts: an introduction for users". University of Cambridge.

[32] Sauvé, A. & M. Scheuer (1999) "Corporate Finance in Germany and France, A Joint Research Project of the Deutsche Bundesbank and the Banque de France", Frankfurt am Main.

[33] Shleifer, A. & R. Vishny (1997) "A survey of corporate governance" Journal of Finance, 737-783.

[34] Smith, C.W.Jr. & R.L. Watts (1992) "The investment opportunity set and corporate …nancing, dividend, and compensation policies", Journal of Financial

Economics, 32, 263-292.

[35]Stulz, R. (1990) “Managerial discretion and optimal …nancing policies” Journal of Financial Economics, 26, 3-27.

[36] Titman, S. & Wessels, R. (1988) “The determinants of capital structure choices” Journal of Finance, 43, 1-19.

[37] Townsend, R. (1979) “Optimal contracts and competitive markets with costly state veri…cation” Journal of Economic Theory, 21, 265-93.

[38] Yoon, Pyung Sig & L.T. Starks (1995) ”Signaling, investment opportunities, and dividend announcements”, Review of Financial Studies, 8(4), 995-1018.

[39] Zwiebel, J. (1996) “Dynamic capital structure under managerial entrenchment” American Economic Review, 1197-1215.

Table 1. Variable descriptions

Debt	Ratio of debt (long-term liabilities, bank loans and overdrafts)
	to total net assets
Q	Market value of equity plus book value of debt
	divided by book value of equity and debt
size	Log of real value of sales (at 1985 prices)
cash ‡ow volatility	Standard deviation of change in real operating income
	divided by mean (over previous 8 years)
employment	Log of number of employees
collateral	Tangible …xed assets plus stocks and work in progress,
	divided by total net assets
¼	Operating income (gross of tax, interest and depreciation)
	divided by total net assets
depreciation	Total depreciation divided by total gross assets
sales growth	3 year average sales growth

Table 2. Static Panel Regressions for Debt and Q

	Debt	Q	Q
	OLS	OLS	IV
Debt	-	0:4480 (5:31)	1:5586 (2:41)
size (sales)	0:0321 (8:64)	-	-
cash ‡ow volatility (£10 ¡6)	7:77 (2:47)	-	-
employment	¡ 0:0037 (1:01)	¡ 0:1027 (6:23)	-0:1207 (6:18)
collateral	0:0421 (2:94)	-0:0553 (0:7)	-0:0998 (1:15)
¼	¡ 0:4858 (20:9)	1:4059 (10:1)	1:9276 (5:80)
¼ lagged	-0:2250 (9:48)	0:7200 (5:21)	0:9527 (4:93)
¼ lagged twice	-0:1205 (5:22)	0:8603 (6:42)	0:9893 (6:44)
$¼^2$	-0:1493 (2:02)	6:3100 (14:8)	6:4940 (14:7)
depreciation	-0:1234 (4:27)	-1:0345 (6:19)	-0:8751 (4:58)
R^2	0.2411	0.3971	0.3908

(i) Regressions include time and individual …xed e¤ects (not reported). F tests for signi…cance of individual …xed e¤ects were for debt regression $F_{556;4639} = 12:6$ and for Q regression $F_{556;4640} = 8:8:$

(ii) t-statistics reported in brackets

(iii) Number of Observations was 5227, number of …rms 557

(iv) Instruments used for debt in Q regression were cash ‡ow volatility and size. F ¡ test that these variables do not appear in the Q regression separately is F (2; 4638) = 2:16, not signi…cant at 10% level.

Table 3. Static Panel Regressions for Debt and Q

	Debt	Q	Q
	OLS	OLS	IV
Debt	-	0:4408 (5:20)	0:0943 (0:10)
size (sales)	0:0255 (5:79)	-	-
cash ‡ow volatility (£10 ¡6)	7:73 (2:45)	-	-
employment	¡ 0:0022 (0:60)	¡ 0:1218 (7:28)	-0:1178 (5:93)
collateral	0:0321 (2:28)	-0:1358 (1:66)	-0:1250 (1:44)
¼	¡ 0:4924 (21:2)	1:3285 (9:45)	1:1600 (2:47)
¼ lagged	-0:2302 (9:66)	0:6633 (4:76)	0:5846 (2:32)
¼ lagged twice	-0:1159 (5:03)	0:8935 (6:67)	0:8534 (4:97)
$¼^2$	-0:1565 (2:12)	6:2671 (14:6)	6:2095 (13:6)
sales growth	0:0351 (3:34)	0:2463 (4:77)	0:2698 (3:32)
R^2	0.2535	0.3701	0.3640

(i) Regressions include time and individual …xed e¤ects (not reported). F tests for signi…cance of individual …xed e¤ects were for debt regression $F_{556;4639} = 12:4$ and for Q regression $F_{556;4640} = 9:6:$

(ii) t-statistics reported in brackets

(iii) Number of Observations was 5227, number of …rms 557

(iv) Instruments used for debt in Q regression were cash ‡ow volatility and size. F ¡ test that these variables do not appear in the Q regression separately is $F(2;4638) = 0:22$, not signi…cant at 10% level.

Table 4. Dynamic Panel Regressions for Debt and Q

	Debt	Q	Q
		Debt uninstrumented	Debt instrumented
Q lagged	-	0:5330 (8:33)	0:5315 (8:18)
Debt	-	0:2700 (2:58)	0:3204 (0:44)
Debt lagged	0:3174 (7:58)	-	-
size (sales)	0:0196 (4:39)	-	-
cash ‡ow volatility (£10 ¡6)	2:83 (1:31)	-	-
employment	0:0066 (1:63)	-0:0818 (3:18)	-0:0824 (2:98)
collateral	0:0174 (1:06)	0:0163 (0:15)	0:0152 (0:14)
¼	-0:3923 (21:0)	0:6234 (4:78)	0:6425 (2:21)
¼2	¡ 0:3293 (6:01)	2:7274 (7:42)	2:7442 (6:44)
depreciation	-0:1793 (4:43)	0:5602 (2:08)	0:5658 (1:94)

(i) Regressions include time and individual …xed e¤ects. Estimated by Anderson Hsiao (by taking …rst di¤erences and using instrumental variables). Instruments used were second lags of the (di¤erenced) dependent variables and lags of the (di¤erenced) explanatory variables. Additional instruments for debt in the Q regression in the third column were size and volatility as in Table 1 and the second lag of debt (all di¤erenced).. F ¡ test that these additional instruments do not appear in Q regression was F (3; 4796) = 0:45

(ii) t-statistics reported in brackets

(iii) Number of Observations was 4827.

Table 5. Dynamic Panel Regressions for Debt and Q

	Debt	Q	Q
		Debt uninstrumented	Debt instrumented
Q lagged	-	0.4990 (7.41)	0.4923 (6.79)
Debt	-	0.2686 (2.53)	-0.1537 (0.20)
Debt lagged	0.3229 (7.44)	-	-
size (sales)	0.0212 (3.20)	-	-
cash flow volatility ($\times 10^{-6}$)	3.02 (1.39)	-	-
employment	0.0024 (0.59)	-0.0737 (2.85)	-0.0712 (2.70)
collateral	0.0004 (0.02)	-0.0315 (0.29)	-0.0305 (0.28)
π	-0.4109 (21.2)	0.5864 (4.50)	0.4244 (1.32)
π^2	-0.2861 (5.10)	2.3050 (6.36)	2.1883 (5.25)
sales growth	-0.0038 (0.26)	-0.0044 (0.07)	0.0100 (0.14)

(i) Regressions include time and individual fixed effects. Estimated by Anderson Hsiao (by taking first differences and using instrumental variables). Instruments used were second lags of the (differenced) dependent variables and lags of the (differenced) explanatory variables. Additional instruments for debt in the Q regression in the third column were size and volatility as in Table 1 and the second lag of debt (all differenced).. $F-$test that these additional instruments do not appear in Q regression was $F(3, 4391) = 0.83$

(ii) t-statistics reported in brackets

(iii) Number of Observations was 4422.

Figure 6.1: Frequency plot of Q

Figure 6.2: Frequency plot of debt