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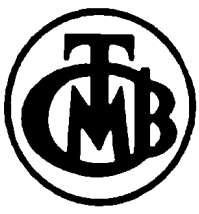

# Access to External Finance: Theory and Evidence on the Impact of Firm-Specific Characteristics

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## Abstract

This paper examines firms' access to bank and market finance when allowance is made for differences in firm-specific characteristics. A theoretical model determines the characteristics such as size, risk and debt that would determine firms' access to bank or market finance; these characteristics can result in greater (or lesser) tightening of credit when interest rates increase. An empirical evaluation of the predictions of the model is conducted on a large panel of UK manufacturing firms. We confirm that small, young and risky firms are more significantly affected by tight monetary conditions than large, old and secure firms.

**Keywords:** External Finance, Monetary Policy Transmission
***JEL* Codes:** E44, E52

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## 1. Introduction

A considerable body of literature has explored the credit channel of monetary transmission under imperfect information including papers by Bernanke and Blinder (1988), Romer and Romer (1990), Friedman and Kuttner (1993), Bernanke and Gertler (1995) to mention just a few. The influence of this channel is felt through the balance sheet (Gertler and Gilchrist, 1994), the effects of bank lending on those firms that are particularly bank dependent (Kashyap, Stein and Wilcox, 1993) and through the stimulation of endogenous cycles or accelerator effects (Fuerst, 1995; Kiyotaki and Moore, 1997, Bernanke *et al.*, 1999). Financial health is used as an indicator to determine firms' access to external funds and therefore when monetary policy tightens real variables such as employment, production, sales, investment and inventory accumulation are influenced not only by higher interest rates but also by a contracting credit supply (Fazzari *et al*., 1988, Guariglia and Schiantarelli, 1998, Nickell and Nicolitsas, 1999, and Guariglia, 1999). The point here is that the influence of information asymmetries can be understood by observing firm-specific characteristics that are good proxies for financial health. Since these characteristic vary considerably the effects of monetary policy contractions are unlikely to be uniform across firms. In fact, the question of just how important for economic activity access to credit might be, and which firms are most affected by it, is an important issue for monetary policy makers. Our paper tackles this subject.

Early attempts to measure the influence of policy tightening on the level of bank lending did not distinguish between demand-side influences, operating through the liabilities side of banks balance sheets (via the interest rate channel), and supply shifts, and therefore could not establish beyond doubt that there was a separate credit channel. But a seminal contribution by Kashyap *et al.* (1993) isolated the influence of monetary policy contractions on bank lending by measuring the *relative* changes of bank lending to non-bank sources of funds. They did so by constructing a 'mix' variable defined as the ratio of bank lending to total external finance (bank lending plus commercial paper). With such a relative measure based on the mix the effect of the interest rate channel on all types of finance could be distinguished from a credit channel on bank lending alone. When Kashyap *et al.* (1993), using US data, showed that the mix between bank lending and market-based finance declined with a monetary contraction they provided strong support for the credit channel in general and the bank lending channel in particular.

Subsequent work by Oliner and Rudebusch (1996) has criticized Kashyap *et al.* (1993). While they were convinced by the use of a mix variable to capture the relative adjustment in the financial portfolio, they were unsure whether Kashyap *et al.* (1993) had used the correct mix. They argued that the original mix variable did not take into account a sufficiently wide range of alternative sources of finance and did not account for differential effects on small as opposed to large firms. Small firms are almost entirely bank dependent and therefore their mix is likely to be invariant to the monetary policy stance. With a wider measure of alternative funds and a distinction between small and large firms, Oliner and Rudebusch (1996) showed that there was less evidence for a bank lending channel than had been originally supposed. Nevertheless, they found that the broad credit channel, which implies that all sources of funds contract simultaneously as monetary policy tightens, leaving the mix unaffected, does exist.

Kashyap *et al.* (1996) responded to this critique by arguing that the re-interpretation of Oliner and Rudebusch (1996) was misleading. The implication that the mix does not respond to monetary policy when the data is disaggregated, they argued, is entirely expected for small firms (because they are bank dependent at all times) and an artefact of the different measure of the mix for large firms. When Kashyap *et al.* (1996) recalculated the effects for small and large firms using their own definition of the mix their original results were upheld.

The interchange between Kashyap *et al.* (1993, 1996) and Oliner and Rudebusch (1996) is far from a minor dispute. It touches on an important issue for this paper – the influence of firm-specific characteristics on the response to monetary contractions. If factors such as the size of the firm – to take the characteristic chosen by Oliner and Rudebusch (1996) – can have an influence on the composition of finance, then other characteristics may also alter access to credit. In other words, why consider only size? In their conclusion Kashyap *et al.* (1996) note that there is 'more to be learned from careful analysis of a variety of micro data, at the level of both individual banks and individual firms' (p. 313), and we agree. Now that micro data is accessible on other aspects of firm characteristics, such as their real assets, perceived riskiness and indebtedness, in panels spanning periods of both tight and benign monetary policy, we can consider their effects. The influence of the above factors on firms' access to bank versus market-based finance, after a change in monetary policy, is the point that the present paper addresses.

We begin by presenting a simple theoretical model that allows us to derive a taxonomy of firms according to their source (if any) of external finance based on their characteristics. Then we

examine access to credit under this taxonomy. Our modelling approach follows Bernanke and Gertler (1989), Diamond (1984) and Williamson (1987) who adopt Townsend's (1979) costly-state verification framework. Banks in this environment have the ability to monitor their clients and thus verify the returns of their projects.[1] In contrast, capital markets (bondholders) are unable to do so because of the free-rider problem. As a result, only firms with healthy balance sheets are able to borrow from the capital market. Undercapitalized firms are forced either to borrow from banks and raise funds at higher interest rates that reflect the cost of monitoring, or self-finance their projects. Monetary policy can affect the access of firms to external finance because it alters the cost of funds. Crucially, from the point of view of our paper, we are interested to know how these effects depend on those firm characteristics that credit providers use to identify creditworthy applicants. Examples of the kind of characteristics that we have in mind are size, total assets, the ratio of tangible to intangible assets, credit ratings, profitability and gearing. The predictions from our model are evaluated for a panel of 16,000 manufacturing firms in the UK. Our results show that the more financially vulnerable firms – smaller, younger, more risky and more indebted firms – are more severely affected by monetary tightening as credit supply is withheld. Thus we offer empirical support for the theoretical model, and can quantify the effects of particular characteristics on access to external finance.

The paper is organized as follows. Section 2 presents our theoretical model that is used to explore the influence of firm-specific characteristics on the variation in the composition of external finance as a consequence of contractions and expansions in monetary policy. The data sources and empirical methodology are discussed in Section 3 followed by the estimations. Section 4 concludes.

## 2. The Theoretical Model

We assume that firms own assets which consist of tangible collateral assets ($C$) and intangible assets. The liability side of their balance sheets consists of equity and debt ($D^S$). The latter is senior relative to any new (junior) debt ($D^J$), in the sense that it will be paid off first in the case of

[1] The ability to monitor is also what distinguishes banks from capital markets in Besanko and Kanatas (1993), Boot and Thakor (1997), Diamond (1991), Holmstrom and Tirole (1997), Hoshi, Kashyap and Scharfstein (1993) and Repullo and Suarez (2000). However, in these models monitoring allows banks to alleviate a moral hazard problem related to the choice of technologies by firms.

default. Since any new finance will be junior to all existing debt raised previously, at the margin the availability of market finance will rest on the likelihood that junior debt will be repaid.

New projects require an initial investment $F$ (project size) and generate financial payoffs $kF$ ($k>1$) with probability $p$ and zero with probability $1-p$. We assume that the projects are socially efficient, i.e. $pkF>F$. Firms need to raise external funds to finance new projects. Firm owners and potential creditors are risk neutral. All financial markets are competitive. The opportunity cost of funds is given by the riskless interest rate $r$, which is also the operational variable of monetary policy used by the Bank of England to target inflation.

Following Townsend (1979), we assume that only firm owners can costlessly observe project returns. Monitoring the activities of firms allows creditors to verify the returns reported by firm owners, but monitoring is costly and only banks find it profitable to monitor their clients.[2]

When firms default on their debt obligations, creditors can liquidate their tangible assets. We assume that the liquidation value of these assets is uncertain at the time when liquidation decisions are taken.[3] More specifically, with probability $\pi$ the value of tangible assets is equal to $C_H$ and with probability $1-\pi$ is equal to $C_L$ ($<C_H$). Let $\pi C_H+(1-\pi)C_L=C$ (i.e. the expected liquidation value is equal to the value of the tangible assets at the time when the financial contract is agreed). Finally, we assume that when liquidation takes place firms also lose any expected discounted continuation payoffs $V$.[4] For simplicity, we impose the following restrictions on the continuation payoffs and the liquidation values:

*Condition* 1: $C_L>D^S$

*Condition* 2: $V>(1-\pi)(D^S+D^J-C_L)$

The first condition states that senior debt is riskless. The second sets a minimum level for the continuation payoffs. As we will show below, there is no loss of generality by imposing these

[2] See Diamond (1984) for a costly-state verification model where financial intermediaries arise endogenously.
[3] In equilibrium liquidation values will be affected by the stance of monetary policy. As Schleifer and Vishny (1992) have pointed out it is during periods of recessions, when most of the bankruptcies take place, that liquidation values are at their lowest levels.

restrictions. We introduce them in order to eliminate some cases that would not further add any new insights to the analysis of our model.

2.1. *Market Finance*

In this section, we consider the case where the only source of external finance is the capital market. Let $D^J_C$ denote the amount of debt raised in the capital market. In the absence of monitoring, firms might have an incentive to misreport their true payoffs. We begin with the following lemma:

*Lemma* 1: *If* $D^S+D^J_C>C_H$ *there exists a cut-off value* $V^*$ *for the continuation payoffs such that if* $V<V^*$ *firms will always default independently of their project's payoff.*

Proof: The expected profit of a firm that truthfully reports its project's payoff is equal to:

$$(1) \qquad p(kF-D^S-D^J_C+V) + (1-p)(\pi(\max\{C_H-C-D^S-D^J_C,-C\}) + (1-\pi)\max\{C_L-C-D^S-D^J_C,-C\})$$

In contrast, the expected payoff of a firm that always defaults is given by:

$$(2) \qquad pkF + \pi(\max\{C_H-C-D^S-D^J_C,-C\}) + (1-\pi)\max\{C_L-C-D^S-D^J_C,-C\}$$

In deriving the above expressions we take into account that payoffs are affected by whether or not liquidation takes place and by changes in the value of tangible assets. When firms default there are two possibilities: either the liquidation value is sufficiently high so that the proceeds cover the total debt obligations or the total payoff to the debtors is restricted by the liquidation value. There are three cases to consider.

Case 1: $C_L>D^S+D^J_C$: In this case all debt is riskless. Since $V$ is strictly positive we find that in this case firms never default when the project payoff is positive.

Case 2: $C_H> D^S+D^J_C>C_L$: Subtracting (1) from (2) we find that condition 2 implies that in this case firms never default when the project payoff is positive.

Case 3: $D^S+D^J_C>C_H$: Subtracting (1) from (2) we find that if $V > D^S+D^J_C-C$ firms will not default when the project payoff is positive.

Then $V^*= D^S+D^J_C-C$.

[4] To keep things simple we have restricted our attention to a static model. This is without any loss of generality, as long as the optimal financial decision at any time is independent of future investment opportunities. Nevertheless, we have introduced a continuation payoff in order to allow for risky capital market financing.

The above lemma has established those conditions under which firms have the incentives to truthfully reveal their payoffs. From the proof it becomes clear that the imposition of conditions 1 and 2 is without any loss of generality. If we remove condition 1 then we will have to consider the effects of senior debt on the incentives of firms to default but would not change the qualitative comparative statics derived below. Condition 2 implies that only in case 3 firms might have an incentive to misreport their payoffs. The following proposition follows directly from the above lemma:

*Proposition* 1: *If* $D^S+D^J_C>C_H$ *and* $V<V^*$ *firms will not be able to fund new projects in the capital market.*

Proof: Lemma 1 implies that when the above inequalities hold firms will default with certainty. In this case the expected liquidation proceeds will be less than the total debt obligations. Because senior debt is paid first the expected payoff of any new debt will be negative.

Proposition 1 sets a maximum value on the amount of junior debt that firms can raise in the capital market. Obviously, the amount of junior debt is endogenous and it depends on the size of the project, the market interest rate and the value of collateral. Next, we calculate $D^J_C$, the available new finance from the capital market, and the rate of interest on new debt. The zero profit condition for creditors requires that:

$$(3) \qquad pD^J_C + (1-p)(\pi(\min\{D^J_C, C_H-D^S\}) + (1-\pi)\min\{D^J_C, C_L-D^S\}) = (1+r)F$$

Lemma 1 implies that we need to consider three cases. Solving for $D^J_C$ we get:

Case 1: If $C_L>D^S+D^J_C$ then

$$D^J_C = (1+r)F$$

Even when the liquidation proceeds are low they are still sufficiently high to cover all debt and therefore junior debt covers the initial investment and the interest, where the effective interest rate on debt $D^J_C/F$ is equal to the gross riskless interest rate. This last point is not surprising given that in this case debt is riskless.

Case 2: If $C_H> D^S+D^J_C>C_L$ then the left-hand side of (3) is equal to

$$pD^J_C + (1-p)(\pi D^J_C + (1-\pi)(C_L-D^S))$$

The inequality $C_L-D^S<D^J_C$ implies that $D^J_C>(1+r)F$ and therefore the effective interest rate on debt $D^J_C/F$ is higher than the gross riskless interest rate.

Case 3: If $D^S+D^J_C>C_H$ and $V>V^*$ then the left-hand side of (3) is equal to

$$pD^J_C + (1-p)(\pi( C_H-D^S) + (1-\pi)(C_L-D^S))$$

Again, the inequality $C_H-D^S<D^J_C$ implies that $D^J_C>(1+r)F$ and therefore the effective interest rate on debt $D^J_C/F$ is higher than the gross riskless interest rate. Indeed the effective interest rate is higher than the corresponding rate in case 2.

Up to this point, we have established under what conditions firms can raise funds in the capital market, we have determined the risk level (if any) of these loans and have calculated the corresponding interest rates. Next, we turn our attention to intermediary finance.

### 2.2. *Intermediary Finance*

In contrast to capital markets, banks can monitor the activities of their clients and thus verify project returns. Townsend (1979) has shown that when monitoring is costly the optimal deterministic contract is the standard debt contract.[5] In our model, this means that banks verify project returns only when firms report that their projects have failed. Under the supposition that banks can impose sufficiently high penalties when firms misreport project returns, firms always have the incentive to report truthfully. We assume that the cost of monitoring $M$ is an increasing function of the size of the project; i.e. $M=m(F)$, $m'(F)>0$.[6]

Monitoring costs make bank credit more expensive than credit from the capital market, therefore, the only firms that seek bank loans will be those that do not have access to the capital market. As we have demonstrated in the previous section, these are firms whose balance sheets satisfy the following two conditions:

$$D^S+D^J_C>C_H \text{ and } V>V^*= D^S+D^J_C-C$$

Let $D^J_B$ denote the amount of new debt owed to banks. The bank's zero profit condition implies that the condition (3) in the previous section should be amended to include the expected monitoring costs, $(1-p)m(F)$, such that:

[5]Townsend (1979) suggested that by expanding the set of admissible contracts to include stochastic ones we can improve the welfare of participants. Boyd and Smith (1994) compare and contrast the two types of contracts. Since there are only two states in our model without loss of generality we restrict attention to deterministic contracts. Allowing for stochastic contracts would mean that banks verify project returns, when firm owners report the low state, only probabilistically. This would reduce expected monitoring costs, and thus the interest rates that banks charge on their loans, but it would require that banks can impose very high penalties on those firms that do not report truthfully. If there is an upper limit on the penalties that banks can charge (even if you would never observe them in equilibrium) then we can focus on deterministic contracts.

[6] If we assume that monitoring costs do not vary with the size of project then the effective interest rate on debt will be decreasing in the size of the loan.

$$pD^{J}_{B} + (1-p)(\pi(C_{H}-D^{S}) + (1-\pi)(C_{L}-D^{S})) = (1+r)F+(1-p)m(F)$$

Solving for $D^{J}_{B}$ we get

$$(4) \qquad D^{J}_{B} = \{(1+r)F+(1-p)m(F) - (1-p)(\pi(C_{H}-D^{S}) + (1-\pi)(C_{L}-D^{S}))\} / p$$

Comparing the interest rates charged by banks to those offered by the capital market we find that the former are higher by the value of the expected monitoring costs. Notice that since the expected payoff of firms is decreasing in $D^{J}_{B}$ if $m''(F)>0$ then there might be firms that are unable to break-even because of the high interest payments. Firms indifferent between investing and being inactive are those whose characteristics satisfy the following equality:

$$(5) \qquad p(kF-D^{S}-D^{J}_{B}+V) + (1-p)\pi(C_{H}-C-D^{S}-D^{J}_{B}) = 0.$$

These will be firms with very low values of collateral, high risk of default, large projects relative to their size, and high levels of accumulated debt. Firms with these characteristics might not be able to get access to external finance.

### 2.3. *Model Predictions*

We consider two sets of predictions arising from the model. First, we wish to know what the model predicts about access to credit at the margin based on observable firm-specific characteristics. This should tell us what creditors infer from factors such as size, profitability, risk, collateral and the debt to equity ratio about the viability of extending (further) short-term and long-term debt[7]. Second, we wish to know what the model predicts about the effect of monetary policy on the overall availability of external debt and how this effect varies with firm characteristics.

We derive the first set of predictions from Proposition 1. We can infer that the higher the level of debt (either existing or new debt), the lower the level of future profitability (captured by $V$), and the lower the value of intangible assets (collateral), the more likely it is that new investments will be financed through short-term bank loans rather than by long-term debt from the markets. If existing debt levels indicate extreme vulnerability then firms may not obtain credit from either source.

[7] Since short-term debt of maturity 1 to 5 years is dominated by bank loans (because the market for commercial paper is not as well developed as it is in the U.S.) we can make a distinction between finance raised predominantly from banks and finance from the capital market. Given also that adjustment at the margin affects the accumulated bank borrowing and market debt in relation to scalars such as total debt, total liabilities or turnover we consider ratios when we put these theoretical predictions to the test.

The value of new debt is endogenous and can be derived using the zero-profit condition for creditors given by (3) (or (4)). This condition implies that the value of new debt is positively correlated with the size of the project, the level of interest rates, the level of risk (captured by the inverse of $p$), and the value of existing debt. The zero profit conditions in each case imply that the value of new debt is negatively correlated with the level of collateral, and the level of economic activity (when the state of the economy is good there is a higher likelihood i.e. larger value of $\pi$ that the value of collateral will be high).

Our theoretical model also predicts that, other things equal, smaller firms are more likely to use bank loans to finance their projects. This is because larger firms might be expected, on average, to be characterized by higher collateral and debt values than smaller firms, therefore according to our model they will also be able to finance, on average, larger projects using market finance. Put differently, if we fix the size of investments then larger firms are more likely to finance them using market funds. We summarize the above predictions in the following Proposition:

*Proposition* 2: *Financing investments with bank loans, rather than raising funds in the capital market, is more likely when (a) the level of existing debt is high, (b) the level of collateral is low, (c) the level of risk is high, (d) the level of future profitability is low, and (e) the level of economic activity is low. Our model also predicts that, other things equal, larger firms are more likely to finance their projects with funds raised in the capital market.*

The second set of predictions relates to the impact of monetary policy on the overall availability of external debt. The following proposition is a direct consequence of the break-even condition (5):

*Proposition* 3: *The volume of market finance will be lower during periods of a tight monetary policy (high interest rates) relatively to periods of loose monetary policy, and the effects of a tightening of monetary policy will be stronger during periods of low economic activity. Firms that are most likely to be affected are those with (a) low expected profits (captured by either/both high risk (low p) or/and low profitability (low k)), and (b) low collateral, and (c) high debt levels.*

In the remaining of this paper we test the above predictions and evaluate their relative impact on external credit in quantitative terms.

## 3. An Application to UK Manufacturing Firms

### *3.1 Data and Methodology*

The FAME database covers all UK registered companies offering up to 11 years of detailed information (modified accounts) for about 500,000 large, small and medium sized UK companies. We construct a sample from the FAME Database that allows us some flexibility in analysing the monetary transmission mechanism and corporate sector finance. The sample is extracted on the following criteria[8]:

- Firms whose primary activity is classified as manufacturing according to 1992 SIC UK Code in England, Scotland, Wales and Northern Ireland [9].
- Firms established prior to 1989 and still reporting for the years 1999 and 2000[10].

On this basis we extract 16,000 manufacturing firms with rich information about firm-specific characteristics. The logarithm of real total assets is used to indicate the impact of SIZE and is calculated by deflating nominal total assets by the relevant sectoral producer price index. Our measure of risk, RISK SCORE, is the QuiScore measure produced by Qui Credit Assessment Ltd, which assesses the likelihood of company failure in the twelve months following the date of calculation. The QuiScore is given as a number in the range 0 to 100; firms with scores above eighty are regarded as secure and those below forty are regarded as high risk.

There are four other measures of firm-specific characteristics that we employ. We introduce AGE as an explanatory variable to measure the importance of track record for the change in the composition of firm external finance; the ratio of tangible assets to total assets to measure COLLATERAL available to support borrowing; the return to capital, PROFIT, which is

[8] The sample is based on figures that were downloaded in October and November 2001. A sample selected at a different time but still using the same criteria is likely to be different because of monthly revisions of firm accounts.
[9] The software also includes 940 firms (5.7 percent of the total sample) whose secondary rather that the primary activity is classified in the manufacturing sector.
[10] In fact, only 3 percent of the firms in the manufacturing industry stopped reporting during the period of 1990-1999. This may stem from either a failure of the company or because the company entered the exemption threshold. These drops are prevalent in the first couple of years of the sample period. Therefore, the sample is not a balanced panel, since firms whose turnover is under the threshold are not observed (the turnover threshold is £90,000).

a measure of profitability scaled by capital; and a measure of senior debt that is captured by GEARING, the ratio of total loans to shareholder funds as an indicator of indebtedness of firms in relation to their equity, and by DEBT(-1), which is debt outstanding at the end of the previous period.

We now turn to our measure of the financial choice. The theoretical model has made predictions about the choice at the margin between bank borrowing and marketable debt, but in the tradition of Kashyap *et al.* (1993) and Oliner and Rudebush (1996), who used ratios of bank loans to total short term debt, we derive ratios that change with decisions at the margin. These help to abstract from demand-side influences to a degree because the factors that influence the uptake of credit from the demand side affect both numerator and denominator leaving the ratio relatively unchanged. Changes in the ratio are more likely to reflect the influence of the supply-side. We have two measures of financial choice based on ratios corresponding to – short-term debt to total debt and total debt to total liabilities.[11] The former refers to access to market finance versus bank finance, where the majority of short term debt is bank finance, while the latter refers to the overall availability of external debt (i.e. total debt).[12]

Our sample offers a natural experiment to evaluate the influence of firm-specific characteristics on the response of corporate finance to monetary policy. The first period of our sample, 1990-1992, was a tight episode, when monetary policy in the UK was dedicated towards maintaining the exchange rate within its target zone in the Exchange Rate Mechanism. The high rates of interest in Germany post-reunification and the perceived weakness of sterling as a currency contributed to keep UK interest rates high during this period in order to meet the external policy objective. The period coincided with a recession and a harsh environment for existing and new corporate borrowers. The second period, 1993-1999, witnessed a period of sustained economic growth, falling unemployment and inflation, and interest rates that quickly approached very low levels in comparison to recent historical experience. The corporate sector experienced an improvement in net worth and borrowing conditions that were less constrained. We make use of this natural experiment by interacting the interest rate during tight and loose periods of monetary policy with the other explanatory variables. Our results, reported in the

[11] Short-term debt is made up of the sum of bank overdrafts, short term-group and director loans, hire purchase, leasing and other short-term loans, but is predominantly bank finance. Total liabilities is made of short-term debt, trade credit and total other current liabilities that include some forms of finance resembling commercial paper or bonds, long term debt and other long-term liabilities.

empirical section, show that there was a marked difference in the response to firm specific characteristics when interacted with monetary policy[13].

We estimate the relationship between the financial choices of firms and their specific characteristics using a standard panel model that enables us to control for firm specific unobservable effects and to account for firm heterogeneity. The format is:

$$y_{it} = \alpha_i + X_{it}\beta + \varepsilon_{it}$$

where $i = 1,2,\ldots, N$ refers to a cross section unit (firms in this study), $t = 1, 2,\ldots..,T$ refers to time period. $y_{it}$ and $X_{it}$ denote the dependent variable and the vector of non-stochastic explanatory variables for firm $i$ and year $t$, respectively. $\varepsilon_{it}$ is the error term, and $\alpha_i$ is a vector capturing firm-specific intercepts. A preliminary investigation that compared estimates from a random effects model against a fixed effects alternative using the Hausman test rejected the hypothesis of no systematic difference between coefficients obtained from the two models. Therefore, we report the fixed effects, which are generally regarded as more efficient[14]. We control for the economic cycle where necessary by including GDP as a regressor and for year effects using year dummies.

*3.2 Response to firms-specific characteristics and control variables*

In Table 1 we evaluate the (supply) response of short-term debt to total debt and total debt to total liabilities to firm-specific characteristics. The theoretical model predicts that the first measure, short-term debt to total debt (which comprises mostly bank lending) will rise for smaller or riskier firms, those with higher levels of debt and less collateral, and with lower profitability, while total debt will increase for larger, less risky, highly collateralized firms with evidence of a good return to capital. When we examine the empirical evidence for these effects we find that the predictions are confirmed in the data. We use the *GDP* growth rate to control for cyclical effects in aggregate level, since an increase in the *GDP* growth rate encourages firms to shift toward non-debt liabilities. There are significant time effects from dummies for 1992, 1993, 1996 (all

[12] Our results were unchanged when we considered the ratios of short-term debt and total debt over total assets.
[13] We also considered the impact of a tight period dummy variable which we set equal to one for the period 1990-1992. We do not report the results in the empirical section because they are almost identical to the results based on the interaction with the interest rate (they are available on request).
[14] Ideally we would like to report dynamic panel GMM-estimates such as those proposed by Arellano and Bond (1991), however, the requirement for instruments under GMM poses a problem for our study. The period when monetary policy was tight occurs only at the very beginning of our sample. If we were to make use of GMM those observations at the beginning of our sample would be lost, and the results would be indicative only of access to credit under a benign period of monetary policy. This would severely undermine the rationale for our empirical work, therefore we rely on fixed effects estimates.

negative, suggesting a shift towards long-term debt as interest rates fell to lower levels). The inclusion of these variables in our panel estimates control for remaining demand-side influences and time effects.

We find strong positive evidence in favour of the theoretical model from our empirical application in Table 1. First, the logarithm of real assets, taken as an indicator of firm *SIZE,* is an important influence on the debt ratios. We observe that firms with more real assets tend to have greater access to long-term debt and reduce their short-term debt, hence the signs of the coefficient for the short-term debt to total debt ratio is negative and for the total debt to total liabilities is positive in response to SIZE.

Second, for the *RISK SCORE*, we expect a negative sign on this measure indicating that safer firms will reduce short-term debt (note, our measure based on the QuiScore rating takes a higher value the less risky the firm is judged to be over the following twelve months). This is what we find, and the negative sign on total debt suggests that a good credit rating is also associated with lower debt in general, possibly because these firms make greater use of non-debt finance.

Third, the ratio of tangible assets in total (COLLATERAL) enhances access to longer-term debt, reducing the proportion of short-term to total debt while increasing total debt in relation to total liabilities as predicted.

Fourth we predict that senior debt has priority over junior debt in our theoretical model should the firm liquidate, and therefore firms with more senior debt are less likely to obtain further access to credit. This may result in less long term debt and greater borrowing in the short term from banks, but equally, if the debt level is high enough to cast doubts over a firm's viability, it may reduce all forms of debt. We measure senior debt using the conventional debt-to-equity ratio (GEARING) but this has a negative influence on the proportion of short-term to total debt and a positive influence on total debt to total liabilities[15]. Both coefficients although small, are highly significant, and they indicate that short-term debt declines and long-term debt

[15] Concern that this finding could be the result of the construction of the dependent variable, since both the dependent variables contain total debt as denominator (numerator) while the explanatory variable also includes total debt in the numerator, led us to investigate further. The results are unchanged if we make use of the level of debt outstanding at the end of the previous period TDEBT(-1) as the measure of senior debt so that there is no arithmetic reason for the dependent and the explanatory variables to be linked. The same results also held if we used other measures of senior debt scaled by real assets or turnover (results not reported). We conclude that the finding is not simply obtained by construction of the variables.

increases, which accords with neither of the scenarios that we discussed above, but further investigation of the impact of debt illustrates why this is the case.

Higher levels of existing debt may deter creditors from offering further long-term credit for firms that are vulnerable on the basis of other characteristics besides debt. For these types of firms long-term debt declines. But for firms that are healthy on the basis of the other characteristics, creditors may be willing to offer more debt as they have done in the past. For these firms greater debt does not indicate vulnerability, but rather is the consequence of their success in accessing credit previously. The type of credit that they are likely to obtain is typically long term debt. If the influence of the latter group outweighs the effects of the former on long-term debt, we would observe growing total debt and declining short-term debt in response to higher debt levels.[16]

We illustrate this point in Table 1-B where we construct interactions between gearing and indicators that demonstrate that a firm is in the upper or lower tail of the distribution with respect to other characteristics (respectively firms above the 25th and below the 75th percentile of the distribution). Thus we can identify the firms that have high profits, low risk and high collateral, that are strong on other criteria other than debt levels, and compare the impact of gearing in their case with the firms that a weak on these criteria. Our results show that risky and highly geared firms in particular are not able to access long-term credit, but can obtain short-term credit, while firms that are secure and highly geared can access long-term credit.[17]

Two other variables need to be discussed. A good rate of return on capital (PROFIT) should improve access to short term and long term debt. In practice we find that it improves access to short term debt but marginally reduces the ratio of total debt to total liabilities. A further variable, AGE, also appears to be a significant explanatory for both short-term and total debt. There is no prediction from our model concerning the impact of this variable, but the empirical finding accords with the predictions of other models. AGE provides a confirmation of the importance of a track record for certain types of firms and this is a direct test of the relationship-banking proposition suggested by Sharpe (1990), Diamond (1991), Rajan (1992) and Boot

[16] Note that this argument cannot be applied to other explanatory variables. Firms may be highly indebted because they are weak or because they are successful, and have obtained long-term credit in the past. We cannot think of unprofitable firms, or firms with low collateral in the same way.

[17] Other interacted criteria such as size and collateral assets seem less influential, since they have coefficients that are insignificantly difference from zero. Gearing interacted with low profit levels seems to reduce access to all types of credit, and vice versa for high profit.

(2000). Firms that are weak on other criteria but nevertheless have a track record are likely to be less financially constrained than firms that are younger and that have not been able to build relationships with their lenders.

We find that monetary policy tightening (higher values of RATE) leads to a tightening of the supply of debt independently of firm-specific characteristics. In all cases a monetary tightening significantly reduces available credit as expected and this supports the broad credit channel (Oliner and Rudebusch, 1996). In the next sub-section we explore in much greater detail how a tightening of monetary policy alters the credit composition directly and indirectly through interaction with the firm-specific characteristics.

*3.3 Monetary Policy, Firm Characteristics and the Financial Mix*

Our main purpose in this section is to report how the response to firm-specific characteristics varies with monetary policy. We report our findings of the impact of monetary policy on credit ratios by constructing interactions between our explanatory variables and the interest rate. These interactive terms tell us how the response to these variables changes when monetary policy (and hence available external finance) tightens, as indicated by the level of the interest rate. We expect to find that the volume of market finance declines as the rate rises, and that smaller firms, those with low profits and collateral, higher risk and greater debt will be proportionately more affected. The results are reported in Table 2.

We report two columns for each ratio to allow for the effects of inclusion and exclusion of GEARING. We find that there is no variation in the impact of GEARING as rates rise, and the responses to the other explanatory variables are unchanged by the exclusion of GEARING. For other variables there are significant differences in the response of creditors with rising rates.

We find that the positive effects of SIZE lessen with higher levels of the interest rate. This means that being larger is less of an advantage in terms of gaining access to capital markets (smaller negative sign for the first ratio) and in terms of gaining more debt (smaller positive sign for the second ratio)[18] as monetary policy tightens. Likewise, the effect of COLLATERAL is less advantageous during these periods, but is still strongly influential.

A better RISK SCORE and a longer period of incorporation (indicated by AGE) are more advantageous with higher interest rates in terms of reducing the short-term to total debt ratio

[18] In all cases the effect of higher interest rates is found by adding the coefficient on the variable to the coefficient on the relevant interactive term e.g. the coefficient on AGE plus the coefficient on AGE*RATE.

(gaining access to the capital market) but less advantageous in gaining more total debt in relation to total liabilities. This reflects the fact that as rates rise the available stock of total debt is more constrained, but firms may still access longer term debt at lower rates of interest if they have better risk scores and are older.

For GEARING and PROFIT, where the original effects were small and marginal, there is no evidence of a significant variation in response to higher levels of the interest rate.

Very similar results were obtained for all these variables when we considered interactions with a dummy variable indicating tight policy for the period 1990-1992. This measure has some advantages in partitioning the data sample between 'tight' and 'loose' periods, but it does not indicate the degree of monetary tightness as the level of the interest rate does. However, because our results were almost identical this confirms that our findings are robust to the measure of tightness or looseness of monetary conditions.

This section has shown that the responses by lenders to firm-specific characteristics differ with the level of the interest rate since size and collateral are less influential when credit markets are tightening, while risk scores and age become more important in these periods. We conclude that there is substantial evidence that the reaction to monetary policy varies considerably because of the influence of the credit channel and it depends heavily on firm-specific characteristics.

## 4. Conclusions

This paper has examined the proposition that credit provision varies across the monetary cycle according to firm specific characteristics. The foundation for the empirical findings is based on a theoretical framework that models access to credit within a costly state verification environment (Townsend, 1979). External finance is available either from the market or from financial intermediaries where only the latter can verify project returns. By evaluating the creditworthiness of firms, external finance can be obtained from these two sources, provided certain zero-profit conditions are satisfied. These conditions determine the availability of credit and the rate charged for borrowing. Our application relies on specific predictions from this model that can be evaluated against a large panel of firm level data.

The results show that smaller, more risky and younger firms are more noticeably affected by monetary tightening than larger, secure, or older firms. The role of asset size and especially tangible assets that can be used as collateral is strongly emphasized. The paper therefore confirms

the findings of major studies relating to the credit channel. Specifically, that there is a broad credit channel effect (Oliner and Rudebusch, 1996), as well as a bank-lending channel (Kashyap *et al.* 1993 and Gertler and Gilchrist, 1994), accelerator effects (Kiyotaki and Moore, 1997, and Bernanke *et al.,* 1996), and evidence consistent with relationship banking when age proxies for the development of such bank-firm relationships (Rajan, 1992, Berlin and Mester, 1999 and Boot, 2000).

We conclude that Oliner and Rudebusch (1996) were right to point out the importance of distinguishing between firm types, but for the UK, the effects of making this distinction do not undermine the findings of Kashyap *et al.* (1993). We observe that the empirical evidence supports Oliner and Rudebusch (1996) since we confirm that size is an important determinant of short term debt availability but other evidence based on other characteristics of the firm such as collateral assets, risk scores and profitability, suggest that size is not the only influence on the availability of credit. We conclude that many firm-specific characteristics, including size, are important determinants of access to short-term and long-term credit.

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## TABLE 1-A: The impact of firm-specific characteristics on access to credit

| | Short Term Debt/Total Debt | | Total Debt/Total Liabilities | |
|---|---|---|---|---|
| **RATE** | -0.219*** | -0.251*** | -0.516*** | -0.575*** |
| | (2.74) | (3.15) | (10.33) | (11.55) |
| **SIZE** | -4.534*** | -3.755*** | 4.081*** | 3.982*** |
| | (18.89) | (16.35) | (27.07) | (27.73) |
| **RISK SCORE** | -0.355*** | -0.287*** | -0.416*** | -0.446*** |
| | (58.35) | (50.29) | (108.73) | (124.21) |
| **COLLATERAL** | -38.492*** | -37.797*** | 14.210*** | 13.987*** |
| | (41.36) | (41.44) | (24.35) | (24.43) |
| **GEARING** | -0.003*** | | 0.003*** | |
| | (17.48) | | (32.16) | |
| **PROFIT** | 0.028*** | 0.019*** | -0.006*** | -0.003*** |
| | (16.47) | (14.24) | (5.63) | (3.32) |
| **AGE** | 0.681*** | 0.604*** | 0.208*** | 0.176*** |
| | (10.06) | (9.00) | (4.92) | (4.18) |
| **GDP** | -0.454*** | -0.478*** | -0.556*** | -0.570*** |
| | (5.28) | (5.59) | (10.36) | (10.65) |
| **Constant** | 123.340*** | 113.807*** | 22.018*** | 27.052*** |
| | (38.83) | (36.70) | (11.05) | (13.91) |
| **year92** | -1.028*** | -1.160*** | 2.232*** | 2.369*** |
| | (3.38) | (3.84) | (11.70) | (12.46) |
| **year93** | -1.452*** | -1.548*** | 0.806*** | 0.723*** |
| | (4.22) | (4.52) | (3.74) | (3.37) |
| **year95** | -0.352 | -0.294 | 0.192 | 0.300* |
| | (1.40) | (1.17) | (1.22) | (1.91) |
| **year96** | -0.754*** | -0.744*** | 0.014 | 0.002 |
| | (2.96) | (2.93) | (0.09) | (0.01) |
| **yea97** | 0.206 | 0.246 | 0.744*** | 0.845*** |
| | (0.74) | (0.89) | (4.28) | (4.86) |
| **year98** | 0.232 | 0.306 | 1.403*** | 1.475*** |
| | (0.73) | (0.97) | (7.04) | (7.41) |
| | | | | |
| **Obs** | 105750 | 109900 | 107428 | 112697 |
| **No of firm** | 14750 | 14980 | 14804 | 15062 |
| **R-squared** | 0.06 | 0.05 | 0.17 | 0.17 |

Absolute value of t-statistics in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%

## TABLE 1-B: Effects of debt interacted with other characteristics

| | Short Term Debt/Total Debt | | | Total Debt/Total Liabilities | | |
|---|---|---|---|---|---|---|
| **RATE** | -0.216*** | -0.214*** | -0.216*** | -0.509*** | -0.519*** | -0.511*** |
| | (2.71) | (2.68) | (2.71) | (10.24) | (10.42) | (10.30) |
| **SIZE** | -4.485*** | -4.429*** | -4.396*** | 4.051*** | 4.117*** | 4.054*** |
| | (18.68) | (18.46) | (18.32) | (26.89) | (27.32) | (26.93) |
| **RISK SCORE** | -0.341*** | -0.333*** | -0.327*** | -0.424*** | -0.430*** | -0.434*** |
| | (55.95) | (54.30) | (53.22) | (110.87) | (111.48) | (112.67) |
| **COLL** | -37.953*** | -38.710*** | -38.276*** | 14.297*** | 14.454*** | 14.346*** |
| | (40.54) | (41.11) | (40.66) | (24.39) | (24.50) | (24.34) |
| **AGE** | 0.676*** | 0.673*** | 0.662*** | 0.224*** | 0.212*** | 0.230*** |
| | (10.03) | (9.97) | (9.84) | (5.31) | (5.03) | (5.46) |
| **GEARING** | -0.009*** | -0.004*** | -0.010*** | 0.008*** | 0.004*** | 0.008*** |
| | (24.59) | (14.43) | (19.56) | (33.48) | (23.17) | (25.70) |
| **GEARING*SMALL** | 0.000 | | 0.000 | 0.001*** | | 0.000 |
| | (1.22) | | (0.25) | (2.80) | | (0.95) |
| **GEARING*RISKY** | 0.008*** | | 0.007*** | -0.005*** | | -0.004*** |
| | (24.27) | | (18.45) | (22.20) | | (16.23) |
| **GEARING*LCOLL** | -0.000 | | 0.000 | 0.001*** | | 0.001*** |
| | (0.54) | | (0.30) | (6.58) | | (4.27) |
| **GEARING*LPROFIT** | -0.002*** | | 0.000 | -0.002*** | | -0.003*** |
| | (5.09) | | (1.18) | (9.45) | | (10.81) |
| **GEARING*LARGE** | | -0.000 | 0.000 | | -0.001*** | -0.001*** |
| | | (0.13) | (0.07) | | (6.86) | (5.74) |
| **GEARING*SECURE** | | -0.015*** | -0.011*** | | 0.011*** | 0.008*** |
| | | (21.66) | (15.38) | | (25.36) | (18.16) |
| **GEARING*HCOLL** | | 0.001*** | 0.001*** | | -0.001*** | -0.001*** |
| | | (3.92) | (3.53) | | (5.50) | (2.83) |
| **GEARING*HPROFIT** | | 0.004*** | 0.005*** | | 0.000 | -0.002*** |
| | | (11.66) | (11.50) | | (0.80) | (6.75) |
| **PROFIT** | 0.031*** | 0.021*** | 0.025*** | -0.013*** | -0.007*** | -0.011*** |
| | (16.95) | (11.37) | (13.25) | (11.60) | (6.09) | (9.08) |
| **GDP** | -0.444*** | -0.450*** | -0.442*** | -0.562*** | -0.557*** | -0.563*** |
| | (5.19) | (5.26) | (5.17) | (10.52) | (10.41) | (10.56) |
| **year92** | -1.002*** | -1.025*** | -1.004*** | 2.208*** | 2.227*** | 2.209*** |
| | (3.30) | (3.38) | (3.32) | (11.63) | (11.72) | (11.66) |
| **year93** | -1.452*** | -1.417*** | -1.430*** | 0.823*** | 0.782*** | 0.802*** |
| | (4.23) | (4.13) | (4.17) | (3.84) | (3.64) | (3.74) |
| **year95** | -0.335 | -0.334 | -0.318 | 0.172 | 0.183 | 0.164 |
| | (1.34) | (1.33) | (1.27) | (1.09) | (1.17) | (1.04) |
| **year96** | -0.700*** | -0.715*** | -0.672*** | -0.026 | -0.009 | -0.043 |
| | (2.75) | (2.81) | (2.65) | (0.16) | (0.06) | (0.27) |
| **year97** | 0.241 | 0.223 | 0.260 | 0.716*** | 0.743*** | 0.709*** |
| | (0.87) | (0.81) | (0.94) | (4.13) | (4.28) | (4.10) |
| **year9** | 0.255 | 0.241 | 0.267 | 1.374*** | 1.406*** | 1.376*** |
| | (0.80) | (0.76) | (0.84) | (6.92) | (7.08) | (6.94) |
| **Constant** | 122.286*** | 121.762*** | 121.440*** | 22.103*** | 22.200*** | 22.323*** |
| | (38.56) | (38.40) | (38.34) | (11.12) | (11.16) | (11.25) |
| **Observations** | 105750 | 105750 | 105750 | 107428 | 107428 | 107428 |
| **Number of firm** | 14750 | 14750 | 14750 | 14804 | 14804 | 14804 |
| **R-squared** | 0.06 | 0.06 | 0.07 | 0.18 | 0.18 | 0.19 |

Absolute value of t-statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

## TABLE 2: Allowing for interactions with the interest rate

| | Short Term Debt/Total Debt | | Total Debt/Total Liabilities | |
|---|---|---|---|---|
| **RATE** | -2.479*** | -2.518*** | -0.965*** | -1.170*** |
| | (12.76) | (13.33) | (7.88) | (9.82) |
| **SIZE** | -7.586*** | -6.811*** | 3.834*** | 3.626*** |
| | (27.26) | (25.34) | (21.85) | (21.43) |
| **SIZE*RATE** | 0.345*** | 0.347*** | 0.037*** | 0.051*** |
| | (18.90) | (19.17) | (3.23) | (4.51) |
| **RISK SCORE** | -0.219*** | -0.146*** | -0.449*** | -0.482*** |
| | (16.37) | (11.85) | (53.87) | (62.77) |
| **RISK SCORE*RATE** | -0.019*** | -0.020*** | 0.004*** | 0.005*** |
| | (12.26) | (13.71) | (4.30) | (5.11) |
| **COLLATERAL** | -46.421*** | -46.483*** | 19.790*** | 19.231*** |
| | (31.13) | (31.65) | (21.08) | (20.80) |
| **COLLATERAL* RATE** | 1.007*** | 1.100*** | -0.737*** | -0.694*** |
| | (6.62) | (7.32) | (7.71) | (7.36) |
| **GEARING** | -0.003*** | | 0.003*** | |
| | (7.73) | | (12.32) | |
| **GEARING*RATE** | 0.000 | | 0.000 | |
| | (1.10) | | (0.05) | |
| **PROFIT** | 0.033*** | 0.018*** | 0.003 | 0.003 |
| | (7.34) | (4.86) | (0.90) | (1.18) |
| **PROFIT*RATE** | -0.000 | 0.000 | -0.001*** | -0.001*** |
| | (0.83) | (0.61) | (3.38) | (2.62) |
| **AGE** | 0.874*** | 0.811*** | 0.094*** | 0.076** |
| | (15.38) | (14.41) | (2.63) | (2.14) |
| **AGE*RATE** | 0.013*** | 0.014*** | -0.004*** | -0.004*** |
| | (11.30) | (11.61) | (5.05) | (4.90) |
| **GDP** | 1.092*** | 1.161*** | -1.326*** | -1.249*** |
| | (3.42) | (3.66) | (6.60) | (6.24) |
| **GDP*RATE** | -0.183*** | -0.193*** | 0.084*** | 0.073*** |
| | (4.87) | (5.18) | (3.54) | (3.10) |
| **year94** | 0.561* | 0.521 | 1.521*** | 1.746*** |
| | (1.71) | (1.60) | (7.35) | (8.48) |
| **year95** | 0.571** | 0.674** | -0.201 | -0.042 |
| | (2.16) | (2.56) | (1.21) | (0.25) |
| **year96** | -0.107 | -0.060 | -0.319** | -0.288* |
| | (0.42) | (0.24) | (1.98) | (1.80) |
| **year97** | 0.410 | 0.454* | 0.755*** | 0.869*** |
| | (1.48) | (1.65) | (4.34) | (5.00) |
| **year98** | 0.493 | 0.560* | 1.447*** | 1.531*** |
| | (1.57) | (1.79) | (7.33) | (7.77) |
| **Constant** | 133.830*** | 123.803*** | 30.568*** | 36.101*** |
| | (41.56) | (39.56) | (15.06) | (18.29) |
| **Obs** | 105750 | 109900 | 107428 | 112697 |
| **No of firm** | 14750 | 14980 | 14804 | 15062 |
| **R-squared** | 0.07 | 0.06 | 0.18 | 0.17 |

Absolute value of t-statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%