The Impact of Firm-Specific Characteristics on the Response to Monetary Policy Actions

by

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Abstract

This paper examines the impact of monetary policy on 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 allow firms to access bank or market finance; these can make a firm more vulnerable to tightening credit when interest rates increase. Empirically, the paper shows, using a panel of 16,000 UK firm records over 10 years, that firms distributed according to their type (asset size, rating etc) do have differing access to bank lending and market finance. Small, young and risky firms are more significantly affected by tight monetary conditions than large, old and secure firms. The evidence is consistent with a credit channel, and demonstrates that there are distributional implications from tightening monetary policy.

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1. Introduction

A considerable body of literature has explored the credit channel of monetary transmission 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 internal and external funds, so that when monetary policy tightens real variables such as employment, production, sales, investment and inventory accumulation are influenced by higher interest rates and by contracting credit supply (Fazzari *et al*., 1988, Guariglia and Schiantarelli, 1998, Nickell and Nicolitsis, 1999, and Guariglia, 1999). The point here is that access to credit is determined by firm-specific characteristics and therefore the effects of monetary policy contractions are unlikely to be uniform. In fact, the question of just how influential the credit channel might be, and which firms are most affected by it, is an important issue for monetary policy makers. Our paper tackles this subject.

A key empirical issue for researchers has been the identification of the credit channel as a separate influence from other channels – such as the interest rate channel, for example. 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) showed that the mix between bank lending and market-based finance declined with a monetary contraction in the US they provided strong support for the credit channel in general and the bank lending channel in particular.

Subsequent work by Oliner and Rudebusch (1996) offered a critique of 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 credit 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. They concluded that disaggregation fails to substantiate that the mix changes as policy tightens, as they could find no evidence to support a bank lending channel, either in aggregate or for small or large firms separately.

Kashyap *et al.* (1996) responded 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 the credit channel – 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 influential effect on the composition of finance, then other characteristics may also alter the responsiveness to monetary policy. 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 balance sheet, 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 how monetary policy affects this taxonomy. Our modelling approach follows Bernanke and Gertler (1989), Diamond (1984) and Williamson (1988) 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.[2] In contrast, capital markets (bondholders) are, because of the free-rider problem, unable to do so. As a result, only firms with healthy balance sheets are able to borrow from the capital market. Undercapitalised 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. Changes in monetary policy can affect the access of firms to external finance because they alter the cost of funds. Crucially, from the point of view of the credit channel, 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, short- and long-term liabilities, 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 the responsiveness to monetary policy.

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 methodology are discussed in Section 3, and Section 4 presents the empirical evidence. Section 5 concludes.

2. The Theoretical Model

We assume that firms own a certain amount of total 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 default. New finance raised on the capital market will be junior to all existing debt raised previously, therefore, at the margin, the availability of market finance will rest on the likelihood that junior debt will be repaid and not subject to default.

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

[2] 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.

efficient, i.e. $pkF>F$. Firms need to raise funds externally 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.[3]

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.[4] More specifically, with probability π 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.[5] 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 restrictions. We introduce them in order to eliminate some cases that would not further add any new insights in 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:

[3] See Diamond (1984) for a costly-state verification model where financial intermediaries arise endogenously.
[4] 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 their lowest level.
[5] 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.

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

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

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

In deriving the above expressions we take into account that payoffs are affected by whether or not liquidation takes place and 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 $V^*= D^S+D^J_C-C$.

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

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

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

This is not surprising given that in this case debt is riskless. Even when the liquidation proceeds are low they are still sufficiently high to cover all debt. As a result the effective interest rate on debt D^J_C/F is equal to the gross riskless interest rate.

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 also define the risk (if any) of these loans and 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.[6] 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 mis-report 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. $M=m(F)$, $m'(F)>0$.

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:

$$pD^J_B + (1-p)(\pi(C_H-D^S) + (1-\pi)(C_L-D^S)) = (1+r)F+(1-p)m(F)$$

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 going bankrupt 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.

[6]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.

2.3. *Model Predictions*

We consider two sets of predictions arising from the model. First, we wish to know what the model predicts about the impact on financial choice at the margin of firm-specific characteristics. This should tell us what the model infers from factors such as size, profitability, risk, collateral and the debt to equity ratio about the choice at the margin between (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. However, notice that the value of new debt is itself 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. Condition (3) (or (4)) also implies 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 π 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. Larger firms might be expected, on average, to be characterised 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 summarise 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 project with funds raised in the capital market.*

[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 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. Results that are consistent with the above predictions will provide strong evidence for the 'credit channel' view of monetary policy transmission.

3. Data Definitions and Empirical 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].

Our database contains 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

[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).

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 secure and those below forty are a 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, GEARING, the ratio of total loans to shareholder funds as an indicator of indebtedness of firms in relation to their equity, the ratio of tangible assets to total assets to measure COLLATERAL available to support borrowing, and the return to capital, PROFIT, which is a measure of profitability scaled by capital.

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 the decision at the margin. These have advantages because they abstract from demand-side influences, which we expect to affect both numerator and denominator, and concern themselves with the influence of supply and firm's preferences. We have two measures of the 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, since the majority of short term debt is bank finance, while the latter refers to the overall availability of external debt (i.e. total debt). In addition we consider ratios of short-term debt and total debt over total assets.

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, relates to the period when monetary policy in the UK was dedicated towards maintaining the exchange rate within its target zone in the Exchange Rate Mechanism. The period coincided with a recession, tightening monetary policy and a harsh environment for existing and new corporate borrowers. This was because high rates of interest in Germany after 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 second period following the recession, 1993-1999, witnessed a period of sustained economic growth, falling unemployment and inflation, and interest rates at historically low levels. The corporate sector experienced an improvement in net worth and borrowing conditions that

[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

were less constrained. Thus we have two successive episodes where the climate for corporate borrowing would have been very different. To measure the monetary policy stance we use the official interest rate to calculate successive changes (either positive or negative) in rates from the beginning of each year, and a dummy variable that indicates when the level of rates was high (tight policy, *TP*). *MPS* denotes the monetary policy stance and the dummy variable *TP* is interacted with all other variables to indicate whether firm's face different conditions when monetary policy is tight.

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. ε_{it} is the error term, and α_i captures firm-specific effects. When we compared a random effects model against a fixed effects alternative, we rejected the hypothesis of no systematic difference between coefficients obtained from the random effects and fixed effects models by using the Hausman test. Therefore, we report the fixed effects estimates because these are more efficient than random effects[12]. We control for the economic cycle where necessary by including GDP as a regressor and for year effects using year dummies.

4. Results

We begin by evaluating the response of short-term debt to total debt and total debt to total liabilities to the firm-specific characteristics and other control variables in our panel estimates. We then move on to the question of how these variables are affected during periods when monetary policy is tight.

4.1 Response to firms-specific characteristics and control variables

other current liabilities that include some forms of finance resembling commercial paper or bonds, long term debt and other long-term liabilities.

[12] Estimates based on an IV estimator – which are robust to the endogeneity bias – suggested that the results are almost identical to those reported here. Therefore we conclude that the extent of the endogeneity bias is very small. However, we also estimated a dynamic panel GMM-estimator such as that proposed by Arellano and Bond (1991). The hypothesis of no serial autocorrelation of residuals was not rejected for the second order Arellano-Bond test, while the Sargan test of over-identifying restrictions, through which the null hypothesis of the validity of the GMM instruments can be tested, was rejected for different versions of the model. Therefore we did not report the results. While our model is robust to firm-specific heterogeneity, since we account for these factors explicitly in our model, we may still encounter endogeneity bias when we introduce dynamic aspects.

Comparing the two columns in Table 1 allows us to evaluate the response of firms with specific characteristics. The model predicts that the first measure, short-term debt to total debt (which is comprised mostly of bank lending) will rise for smaller or riskier firms, those with higher levels of debt and less collateral, and with lower profitability. The model also predicts that debt in general will increase for larger, less risky, low debt, highly collateralised firms with evidence of a good return to capital. We examine the empirical evidence for these effects once we have controlled for the impact of the cycle by including the *GDP* growth rate and year dummies.

Taking the logarithm of real assets as an indicator of firm *SIZE* it is an important influence on the debt ratios. We expect to find that larger firms have greater access to market finance, but also that the larger a firm happens to be the greater the level of total debt accessible to the firm. We observe the correct signs for the short-term debt to total debt ratio (negative) and for the total debt to total liabilities (positive). This is the first correct prediction for the model.

The model also predicts that as risk falls so the firms will shift away from short-term debt. Our measure of the risk, the QuiScore rating (*RISK SCORE*), takes a higher the value the less risky the firm is judged to be over the following twelve months, therefore, we expect a negative sign on this measure indicating that safer firms will reduce short-term debt. The negative sign on total debt suggests that a good credit rating is associated with lower debt in general, possibly because these firms make greater use of equity issues. This is the second correct prediction of the model.

Age appears to be a significant explanatory for both short-term and total debt[13]. There is no prediction from our model concerning the impact of AGE, but the empirical finding accords with the predictions of other literature 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), Rajan (1992) and Boot (2000). Small and financially weak firms, that nonetheless have a track record are less likely to be financially constrained because they have a better chance to receive bank finance.

Firm's debt to equity ratios (GEARING) appears with a small negative influence on short-term debt and a small positive influence of about the same magnitude on total debt. This runs counter to the prediction of our model for short-term debt and total debt, ut in both cases the sign could result from the fact that debt appears in the dependent and explanatory variables. From an arithmetic point of view, as total debt increases raising gearing, short-term debt to total debt would fall and total debt to total liabilities would increase (as we find empirically).

[13] Implication on *AGE* is not observed directly from theoretical model given above but AGE is a variable reflecting the track record discussed by Diamond (1991) that is a version of our model.

The ratio of tangible assets in total (COLLATERAL) on the other hand is very important as our model predicts. Greater collateral enhances access to both intermediary and market finance, reducing the proportion of short-term to total debt but increasing total debt in relation to total liabilities.

A good rate of return on capital (PROFIT) improves access to short term debt, but reduces the ratio of total debt to total liabilities. This is a puzzling result since higher profit should lead to an increase in debt of all types. The failure to detect the anticipated result may occur because we have measured profitability as the return to capital (dividing profit by the capital stock), and have taken the contemporaneous measure not the expected future value.

We use *GDP* growth rate to control for cyclical effects in aggregate level. An increase in the *GDP* growth rate encourages firms to shift toward to non-debt liabilities. There are significant time effects from dummies for 1992, 1993, 1996 (all negative, suggesting a shift towards long-term debt as interest rates fell to lower levels). The inclusion of these variables in all panel estimates controls for demand-side influences, and time effects.

Monetary policy tightening (higher values of BRATE) leads to a shift out of short and long term debt as expected, and loosening policy induces firms to borrow more. In the next sub-section we explore in much greater detail how tightening of monetary policy alters the debt ratios directly and indirectly through interaction with the firm-specific characteristics.

4.2 Monetary Policy, Firm Characteristics and the Financial Mix

We report our findings of the impact on debt ratios during tight periods of monetary policy by constructing interactive terms with the other explanatory variables using a dummy variable set equal to one in the years 1990-2. These interactive terms tell us how the response to these variables changes when monetary policy (and hence available external finance) is tight. We expect to find that the volume of market finance declines during tight periods of monetary policy, 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: the first allows for interactions only with the firm-specific characteristics, while the second allows for interaction with the measure on monetary stance (effectively testing whether the response of the ratios to a change in monetary policy (interest rates) of the same magnitude alters as monetary policy tightens). In practice, the effect of this alteration on the response to firm-specific effects is nil, but there is evidence that there is a larger response in the ratios to a change in interest rates when rates are already high (during tight periods). For both ratios the signs

and magnitudes of the responses reported in Table 1 are unchanged (excepting for AGE because the tight policy occurred during an earlier time period when AGE of firms was lower).

When we consider the effects of the interactive terms on the firm-specific effects we find that the effect of size lessens in tight periods. Hence, 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)[14] than the loose period of monetary policy. Likewise, the effect of collateral is less advantageous in tight periods, but still strongly influential.

A better risk score and a longer period of incorporation (indicated by AGE) are *more* advantageous in tight periods of monetary policy in terms of reducing the short-term to total debt ratio (gaining access to the capital market) but less advantageous in gaining more total debt in relation to total liabilities. This reflects the fact that in tight periods available debt in total is more constrained, but firms can access longer term debt at lower rates of interest if they have better risk scores and are older.

For gearing and profitability, where the original effects were small and marginal, there is no significant variation in response in tight periods of monetary policy.

Oliner and Rudebusch (1996) criticize Kashyap *et al.* (1993), who find support for the bank lending channel from aggregate data, by claiming that the decline in their mix measure is more likely to originate from shifting bank loans between small and large firms, and not necessarily from a decline in the supply of bank funds. We observe that the empirical evidence supports Oliner and Rudebusch (1996) to some extent, since we confirm a shift in bank loans *does* correspond to the availability of short term debt based on size, but this result does not undermine the evidence for the bank lending channel. Other variables are important determinants of the debt ratios, especially collateral assets and risk scores, suggesting that size is not the only influence on the availability of credit. We conclude that many firm-specific effects, including size, are important determinants of access to credit markets and intermediary finance. In this paper we have been able to quantify the responses to these characteristics and confirm that they match the predictions from a costly state verification theoretical model. Also we can show that the responses when monetary policy is tight, reported in Table 2, show size and collateral to be 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 for different reactions to monetary policy through the influence of the credit channel and these depend heavily on firm-specific characteristics, which we explore in more detail than the previous literature.

[14] In all cases the effect in tight periods 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 AGETP.

5. Conclusions

This paper has re-examined the evidence for credit channels on the composition of corporate finance during tight and loose periods of monetary policy. The paper has proposed a new theoretical framework, based on Townend (1979) costly state verification approach. This model makes predictions about the response in financial structure to firm-specific characteristics and monetary policy conditions. Using firm level data for 16,000 firms over a decade allows us to test the predictions based on size, credit rating, age and debt, collateral and profitability to determine whether monetary policy tightening influences the balance between short-term and long-term debt.

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 emphasised. The paper therefore confirms the findings of major US studies relating to the credit channel, and suggests that these features are also present in UK data. Specifically, there is a broad credit channel effect (Oliner and Rudebusch, 1996), a bank-lending channel (Kashyap *et al.* 1993 and Gertler and Gilchrist, 1994), accelerator effects (Kiyotaki and Moore, 1997, and Bernanke *et al.*, 1999), 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).

The effect of the tightening of monetary policy is felt more severely by firms that have adverse financial characteristics such as poor risk ratings, a short track record, low real assets and collateral compared to the large, financially healthy, long-established companies with good credit ratings. We conclude that Oliner and Rudebusch (1996) were right to point out the importance of distinguishing between firm types, but in the UK, the effects of making this distinction do not undermine the findings of Kashyap *et al.* (1993) as they did in the US. Our investigation has uncovered new dimensions to the influence of firm-specific characteristics, besides size, on the impact of monetary policy through the credit channel.

References

Arellano, M. and S. Bond (1991) 'Some Tests of specification for Panel Data: Monte Carlo Evidence and An Application to Employment Equations', *Review of Economic Studies*, 58, 277-97.

Basu, P. and A. Guariglia (2002) 'Liquidity Constraints and Investment Return Behaviour', *Economica*, 69, 563-81.

Berlin, M. and L.J. Mester, (1999). 'Deposits and Relationship Lending', *Review of Financial Studies*, 12, 579-607.

Bernanke, B S. and A. S. Blinder (1988) 'Credit, Money and Aggregate Demand' *American Economic Review*, 78, 435-39.

Bernanke, B.S. and M. Gertler (1989) 'Business Fluctuations and the Choice between Internal and External Finance', *American Economic Review*, 79, 14-31.

_____(1995) 'Inside the Black Box: The Credit Channel of Monetary Policy Transmission' *Journal of Economic Perspectives*, 9, 27-48.

_____ (1996) 'The Financial Accelerator and the Flight to Quality', *Review of Economics & Statistics*, 78, 1-15

_____and S. Gilchrist (1999) "The Financial Accelerator in a Quantitative Business Cycle Framework" in J.B. Taylor and M. Woodford, eds, *Handbook of Macroeconomics Volume 1C*, Chapter 21, 1341-93: Elsevier, North-Holland.

Besanko, D. and G. Kanatas (1993) 'Credit Market Equilibrium with Bank Monitoring and Moral Hazard', *Review of Financial Studies*, 6, 213-32.

Boot, A.W.A. (2000) 'Relationship Banking: What Do We Know?' *Journal of Financial Intermediation*, 9, 26-56.

_____ and A. Thakor (1997) 'Financial System Architecture', *Review of Financial Studies*, 10, 693-733.

Boyd, J. and B. Smith (1994) 'How Good are Standard Debt Contracts? Stochastic versus Non-Stochastic Monitoring in a Costly State Verification Environment', *Journal of Business*, 67, 539-61.

Carey, M., M. Post and S.A. Sharpe (1998) 'Does Corporate Lending by Banks and Finance Companies Differ? Evidence on the Specialization in Private Debt Contracting', *Journal of Finance*, 53, 845-78.

Chant, J., (1992) 'The New Theory of Financial Intermediation.' in K. Dowd and M. K. Lewis (Editors) *Current Issues in Financial and Monetary Economics*. Basingstoke, Hampshire. Macmillan, 42-65.

Diamond, D. (1984) 'Financial Intermediation and Delegated Monitoring' *Review of Economic Studies*, 51, 393-414.

_____(1991) 'Monitoring and Reputation: The Choice Between Bank Loans and Directly Placed Debt', *Journal of Political Economy*, 99, 689-721.

Fazzari, S.G., G. Hubbard and B. Petersen, (1988) 'Financing Constraints and Corporate Investment' *Brookings Papers on Economic Activity*, 2, 141-95.

Fisher, J.D. (1999) 'Credit Market Imperfection and the Heterogeneous Response of Firms to Monetary Shocks', *Journal of Money, Credit and Banking*, 31, 187-211.

Friedman, B. and K. Kuttner (1993) 'Economic Activity and the Short-Term Credit Markets: An Analysis of Prices and Quantities', *Brookings Papers on Economic Activity 2*, 193-266.

Fuerst, T.S.(1995) 'Monetary and Financial Interaction in the Business Cycle', *Journal of Money, Credit and Banking*, 27, 1321-38.

Guariglia, A. (1999) 'The Effects of Financial Constraints on Inventory Investment: Evidence from a Panel of UK Firms', *Economica*, 66, 43-62.

_____and F. Schiantarelli (1998) 'Production Smoothing, Firms' Heterogeneity, and Financial Constraints: Evidence from a Panel of UK Firms', *Oxford Economic Papers*, 50, 63-78.

Gertler, M. and S. Gilchrist (1994) 'Monetary Policy, Business Cycles and the Behavior of Small Manufacturing Firms', *Quarterly Journal of Economics*, 109, 309-40.

Holmstrom, B. and J. Tirole (1997) 'Financial Intermediation, Loanable Funds and Real Sector', *Quarterly Journal of Economics*, 112, 663-91.

Hoshi, T., A. Kashyap and D. Schafstein (1993) 'The Choice Between Public and Private Debt: An Analysis of Post-Deregulation Corporate Financing in Japan', NBER Working Paper No. 4317.

Kashyap, A. K., and J.C. Stein and D.W. Wilcox (1993) 'Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance', *American Economic Review*, 83, 78-98.

_____. (1996) 'Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance', *American Economic Review*, 86, 310-14.

Kashyap, A.K., O.A. Lamont and J.C.Stein (1994) 'Credit Condition and the Cyclical Behavior of Inventories', *Quarterly Journal of Economics* 109, 567-92.

Kishan, R.P. and T. P. Opiela (2000) 'Bank Size, Bank Capital, and the Bank Lending Channel', *Journal of Money, Credit and Banking*, 2000, 32 , 121-41

Kiyotaki, N., and J. Moore (1997) 'Credit Cycles', *Journal of Political Economy*,105, 211-48.

Myers, S. and N. Majluf (1984) 'Corporate Financing and Investment Decisions when Firms Have Information that Investors Do Not Have', *Journal of Financial Economics*, 13, 187-221.

Oliner, S., and G. Rudebusch (1996) 'Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance: Comment', *American Economic Review*, 86, 300-9.

Nickell, S. and D. Nicolitsas (1999) 'How Does Financial Pressure Affect Firms?' *European Economic Review*, 43, 1435-56.

Rajan, R.G. (1992) 'Insiders and Outsiders: The Choice Between Informed and Arms-Length Debt', *Journal of Finance*, 47, 1367-400.

Repullo, R. and J. Suarez. (2000) "Enterpreneurial Moral Hazard and Bank Monitoring: A Model of the Credit Channel" *European Economic Review*, 44, 1931-50.

Romer, C. D., and D.H. Romer (1990) 'New Evidence on the Monetary Transmission Mechanism', *Brookings Papers on Economic Activity*, 1, 149-213.

Sharpe, S.A. (1990) 'Asymmetric Information, Bank Lending, and Implicit Contracts: A Stylized Model of Customer Relationships', *Journal of Finance*, 45, 1069-87.

Schleifer, A. and R. Vishny (1992) 'Liquidation Values and Debt Capacity: A Market Equilibrium Approach', *Journal of Finance*, 47, 1343-66.

Tonsend, R. (1979) 'Optimal Contracts and Competitive Markets with Costly State Verification', *Journal of Economic Theory*, 21, 265-93.

Williamson, S. (1987) 'Financial Intermediation, Business Failures, and Real Business Cycles', *Journal of Political Economy*, 95, 1196-216.

TABLE 1

	Short Term Debt/Total Debt	**Total Debt/Total Liabilities**
BRATE	-0.022***	-0.044***
	(2.87)	(9.26)
SIZE	-4.534***	4.081***
	(18.89)	(27.07)
RISK SCORE	-0.355***	-0.416***
	(58.35)	(108.73)
AGE	0.787***	0.615***
	(15.82)	(19.73)
GEARING	-0.003***	0.003***
	(17.48)	(32.16)
COLLATERAL	-38.492***	14.210***
	(41.36)	(24.35)
PROFIT	0.028***	-0.006***
	(16.47)	(5.63)
GDP	-0.512***	-0.694***
	(5.01)	(10.88)
Constant	119.445***	7.836***
	(49.46)	(5.17)
year92	-0.973***	2.342***
	(3.28)	(12.61)
year93	-1.408***	1.010***
	(4.23)	(4.85)
year95	-0.349	-0.122
	(1.38)	(0.77)
year96	-0.950***	-0.844***
	(3.26)	(4.62)
year97	0.042	-0.272
	(0.16)	(1.64)
year99	-0.519	-2.046***
	(1.39)	(8.72)
Observations	105750	107428
Number of firms	14750	14804
R-squared	0.06	0.17

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

TABLE 2

	Short Term Debt/Total Debt		**Total Debt/Total Liabilities**	
BRATE	0.033***	-0.008	-0.113***	0.017***
	(3.56)	(0.83)	(19.36)	(2.73)
BRATETP		-0.085***		-0.058***
		(5.61)		(6.06)
SIZE	-5.407***	-5.407***	4.185***	4.185***
	(22.22)	(22.22)	(27.30)	(27.30)
SIZETP	1.320***	1.320***	-0.079	-0.079
	(12.00)	(12.00)	(1.14)	(1.14)
RISK SCORE	-0.335***	-0.335***	-0.422***	-0.422***
	(50.76)	(50.76)	(101.66)	(101.66)
RISK SCORE TP	-0.103***	-0.103***	0.026***	0.026***
	(10.98)	(10.98)	(4.49)	(4.49)
AGE	1.510***	0.985***	0.561***	0.129***
	(17.05)	(18.67)	(10.04)	(3.89)
AGETP	0.097***	0.097***	-0.030***	-0.030***
	(13.45)	(13.45)	(6.62)	(6.62)
GEARING	-0.003***	-0.003***	0.004***	0.004***
	(15.25)	(15.25)	(28.08)	(28.08)
GEARING TP	0.000	0.000	-0.000	-0.000
	(0.29)	(0.29)	(0.62)	(0.62)
COLLATERAL	-39.989***	-39.989***	14.987***	14.987***
	(41.56)	(41.56)	(24.77)	(24.77)
COLLATERAL TP	4.944***	4.944***	-2.913***	-2.913***
	(5.46)	(5.46)	(5.12)	(5.12)
PROFIT	0.031***	0.031***	-0.004***	-0.004***
	(16.02)	(16.02)	(3.42)	(3.42)
PROFIT TP	-0.005	-0.005	-0.009***	-0.009***
	(1.46)	(1.46)	(4.08)	(4.08)
GDP	2.065***	0.113	-2.064***	-0.729***
	(8.07)	(0.85)	(12.78)	(8.71)
GDPTP	-2.889***	0.092	2.047***	-0.212
	(9.08)	(0.34)	(10.21)	(1.25)
Constant	90.950***	116.986***	16.175***	21.416***
	(24.00)	(46.49)	(6.75)	(13.52)
year92		-3.453***		3.244***
		(6.88)		(10.24)
year93	4.450***		-1.498***	
	(7.22)		(3.85)	
year95	2.299***	0.299	-0.956***	
	(6.59)	(1.08)	(4.35)	(5.95)
year96	2.289***	-0.173	-2.752***	-0.616***
	(5.69)	(0.70)	(10.86)	(3.99)
year97	-0.102	-0.005	-0.276*	-0.167
	(0.39)	(0.02)	(1.67)	(1.02)
year99	1.549***		-4.498***	
	(3.62)		(16.73)	
Observations	105750	105750	107428	107428
Number of firms	14750	14750	14804	14804
R-squared	0.06	0.06	0.18	0.18

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