CFCM

CENTRE FOR FINANCE AND CREDIT MARKETS

Working Paper 09/04

Do Financial Factors Affect The Capital-Labour Ratio: Evidence From UK Firm-Level Data

Marina-Eliza Spaliara

Produced By:

Centre for Finance and Credit Markets
School of Economics
Sir Clive Granger Building
University Park
Nottingham
NG7 2RD

Tel: +44(0) 115 951 5619
Fax: +44(0) 115 951 4159
enquiries@cfcm.org.uk

CFCM

Do financial factors affect the capital-labour ratio? Evidence from UK firm-level data

Marina-Eliza Spaliara[a,*]

[a]*Department of Economics, Loughborough University, LE11 3TU, UK*

This version: April 27, 2009

Abstract

This paper analyses how firms' capital-labour ratio is affected by cash flow, leverage, and collateral, and how this effect differs at firms more and less likely to face financing constraints using a rich UK firm-level data set. It is common in the literature to examine the impact of financial constraints on hiring and firing decisions separately from their impact on decisions related to investment in physical capital. We argue that as long as firms use both inputs in production and there is some substitutability between them, the two decisions need to be jointly analysed. When we differentiate across firms that are more or less financially constrained, we find that the former group exhibits higher sensitivities of the capital-labour ratio to firm-specific characteristics compared to the latter.

JEL classification: E22; D92; E44
Keywords: Firm-specific characteristics; Capital-labour ratio; Financial constraints

---

* Corresponding author. Tel.: + 44 (0) 1509 222707; fax: + 44 (0) 1509 223910.
E-mail address: M.Spaliara@lboro.ac.uk

1. Introduction

This paper analyses how firms' capital-labour ratio is affected by cash flow, leverage, and collateral, and how this effect differs at firms more and less likely to face financing constraints. A large number of theoretical and empirical studies have shown that the firm's financial position is important for its fixed investment and employment decisions under imperfect financial markets (see Hubbard (1998) and Bond and Reenen (2006), for surveys). Recent evidence from the UK, presented by Carpenter and Guariglia (2008) and Guariglia (2008), reveal that the firm's fixed investment choice and credit frictions are indeed interrelated.[1] The literature on financial factors and employment decisions is scarce and Benito and Hernando (2008) provide comprehensive evidence that flexible labour may have more positive consequences for employment in the presence of financial constraints. Overall, empirical studies of firm investment and employment strongly suggest that changes in net worth and consequently in firms' real decisions (investment, employment) arise from information problems in financial markets. Campello et al. (2008) show that these changes are amplified during the current credit crisis as financially constrained firms in the US plan to reduce, amongst other real decisions, employment and capital investment in 2009.

The scholarly literature on employment suggests that highly leveraged firms appear to be less prone to hoard labour than less leveraged firms (Sharpe (1994)). In addition, a large number of empirical findings document negative effects of leverage and debt service on employment (Cantor (1990); Nickell and Nicolitsas (1999) and Benito and Hernando (2008)). On the other hand, empirical findings from the fixed investment literature are more controversial and in particular the issue of whether a positive and statistically significant relationship between investment and cash flow can be seen as an indicator of financing constraints. Fazzari et al. (1988) (henceforth FHP (1988)) use *a priori* measures of financial constraints and find that the sensitivity of investment to cash flow is particularly large for firms that have trouble raising external funds (i.e financially constrained firms that face high agency costs). A significant challenge to FHP's (1988) conclusions came with Kaplan and Zingales (1997). They argue that there

[1] Both studies highlight the significance of financial constraints on the firm's investment decisions after controlling for investment opportunities and distinguishing between internal and external constraints.

is no theoretical basis for this relationship and present empirical evidence that less financially constrained firms (firms with a low agency cost) exhibit significantly greater investment-cash flow sensitivities compared to the more constrained firms.[2]

Our motivation for modelling the effects of financing constraints on the capital-labour ratio (*K/L*) stems from simple theoretical considerations. We argue that as long as firms use both inputs in production (capital and labour) and there is some substitutability between them, the two decisions need to be jointly studied. Consider the following example. Under the assumption of constant returns to scale (CRS), suppose that two firms (firm 1 and firm 2, which differ in their ability to raise external finance) experience a permanent increase in the demand for their product. Firm 1, which is less likely to be financially constrained, operates at full capacity and expands both inputs by using external finance and internal funds. With that in our mind we should expect the firm-level *K/L* ratio to remain constant. On the other extreme, firm 2, which is more likely to be financially constrained, might not be able to borrow the funds for the capital investment and might satisfy partially the demand by hiring more labour (constrained firms by definition cannot invest optimally in capital, due to the lumpiness and cost of capital). For the latter firm we should anticipate a decline in the *K/L* ratio. A study that considers the effects of financial factors on both investment and hiring decisions would be able to make the above distinction. In other words, how more and less constrained firms allocate their funds on capital and on labour to reach a target *K/L* ratio when decisions on both inputs have to be taken simultaneously rather than independently?

Motivated by such issues, this paper presents evidence of a link between the capital-labour ratio and firm-specific characteristics under the presence of capital market imperfections, which is an issue that has largely been neglected in the literature. A rare point of reference is Garmaise (2008), who shows that financially restricted firms will have lower *K/L* ratios because informed employees provide more efficient financing than uninformed capital suppliers.[3] Yet,

[2] An attempt to shed some light on the debate comes from Tirole (2006) who develops a simple model of credit rationing and uses it to illustrate the role of net worth. He concludes that unless one has more precise information about the actual heterogeneity of firms, it is difficult to predict how the sensitivity of investment to cash flow varies with an *a priori* measure of financial constraints. Recent insights on the debate have been offered by Agca and Mozumbar (2008) and Brown and Petersen (2009) who show a substantial decline in the investment cash flow sensitivity for physical investment over time.

[3] In his paper owner's characteristics, indices for the bank concentration and rejections of owner's loan applications are considered as proxies for financial constraints.

this approach does not tell us *how* sensitive the *K/L* ratio is to firm-specific characteristics, nor *how* capital market imperfections can affect firms' decisions on the *K/L* ratio. In examining diagrammatically a rich financial dataset of UK manufacturing firms for the period 1994-2004 we show that small firms (more likely to be constrained) face a lower *K/L* ratio in contrast with large firms (less likely to be constrained). Figure 1 illustrates the relevance of firm-level heterogeneity to the understanding of the firm's decisions on the capital-labour ratio. We observe that the *K/L* ratio evolves differently between firm classes, with large firms exhibiting consistently higher values across years compared to the small group of firms. In the main part we present empirical evidence that the financial position of firms drives the heterogeneous responses of the *K/L* ratio among different firm classes.

The value added of the present paper is four-fold. First, we examine the relationship between the *K/L* ratio and balance-sheet indicators. Financial status is a vague term for describing firms' net worth and a number of balance sheet indicators have been used in the literature as measures of financial healthiness (see Benito and Hernando (2007) and Guariglia (2008)). We estimate the responsiveness of the *K/L* ratio to variations in firm-specific characteristics, such as cash flow, leverage and collateral. Second, the focus of attention is on the impact of capital market imperfections. Given that a firm's choice to use capital and labour may reflect its financial position, financial factors become a central element. Hence, it is of particular interest to examine the sensitivity of the *K/L* ratio to firm-specific characteristics for more and less constrained firms. Third, this study explores the role of firm-specific interest rates. According to the theory of the financial accelerator (Bernanke et al. (1999)), the interest paid by firms with weak balance sheets should react more to monetary policy shocks than the interest paid by firms with strong balance sheets. We intend to show how deteriorations in financial health and increases in the cost of finance, affect the *K/L* ratio for more and less constrained firms.[4] Finally, a unique feature of this paper is the large panel of financial data on UK firms, extracted from the FAME database, most of which are unquoted on the stock market. Having access to financial variables for unquoted firms provides a unique opportunity to test the financial constraints hypothesis.

[4]Benito and Whitley (2003) and Mojon et al. (2002) have employed a firm-specific interest rate (implicit interest rate) to analyse the effects of a change in "monetary policy" on firms' behaviour.

The remainder of the paper is laid out as follows. Section 2 presents our classification schemes and illustrates a preliminary data analysis. In section 3 we present our baseline specifications and our econometric methodology. In section 4 we discuss the estimation results, while in section 5 some robustness tests are presented. Section 6 concludes.

2. Data analysis and classification schemes

This section presents the sample separation criteria along with a descriptive and graphical presentation of the data. The data are presented in primarily graphical form to illustrate variation in the cross-sectional distributions of outcomes and how these have varied over time. This provides a precursor to the more formal analysis of how the capital-labour ratio, of different firm classes, responds to financial constraints.

2.1. Sample separation criteria

To depict responses of firms to capital market imperfections, we first have to partition them according to whether they are more or less likely to face financial constraints. There are quite a number of approaches based on criteria such as size and age (Devereux and Schiantarelli (1990) and Gertler and Gilchrist (1994)), bank dependency (Kashyap et al. (1993); Oliner and Rudebusch (1996) and Guariglia and Mateut (2006)), the dividend payout ratio (Fazzari et al. (1988)) and collateral ratio (Carpenter and Petersen (2002); Almeida et al. (2004) and Guariglia and Mateut (2006)). Following the bulk of the literature and the advantageous characteristics of the data, we create three different measures of financial constraints, these are size, age and bank dependency. The above measures are more likely to capture the degree of asymmetric information faced by our firms in capital markets. We use the 75 percent cut-off value[5] and we allow firms to switch across firm categories over time.[6]

Our first separation scheme, size, is based on the firm's real total assets. Gertler and Gilchrist (1994) use this variable as a proxy for capital market access for firms in the manufacturing sector. Further, Bougheas et al. (2006), Greenaway et al. (2007) and Guariglia and

[5] Greenaway et al. (2007) utilise the FAME database and partition firms to more or less financially constrained using the 75 percent cut-off value.

[6] For this reason, our empirical analysis will focus on firm-years rather than simply firms. See Kaplan and Zingales (1997) and Guariglia (1999) for a similar approach.

Mateut (2006) base their group classification on the firm's real total assets. It is sensible to use size as a measure of financial constraints since small firms are associated with a higher degree of information asymmetry, are young and less known and therefore more likely to be vulnerable to capital market imperfections. Thus, we might expect that the sensitivity of the *K/L* ratio to financial variables to be higher for small firms compared to their large counterparts. We generate a dummy variable, $SMALL_{it}$, which is equal to 1 if firm *i's* real assets are in the bottom 75 percent of the distribution of the real assets of all firms operating to the same industry as firm *i* in year *t*, and equal to 0 otherwise.

Following Devereux and Schiantarelli (1990) and Gertler and Gilchrist (1994) we employ age as our second separation scheme. Firms are classified according to their age in order to measure the importance of track record. An old established firm might have higher values of assets and sales compared to a young and growing firm, and therefore it is more likely to have access to the capital market. Hence, young firms have a higher probability to face problems of asymmetric information. In our case we should expect young firms to face a more sensitive *K/L* ratio. We create the dummy $YOUNG_{it}$, which is equal to 1 if age for firm *i* is in the bottom 75 percent of the distribution of the age of all firms operating to the same industry as firm *i* in year *t*, and equal to 0 otherwise.

The last scheme is an indicator of the firm's bank-dependence, called the mix. It is defined as the ratio of the firm's short-term debt to its total debt and it was introduced by Kashyap et al. (1993).[7] The mix refers to access to market finance versus bank finance, where the majority of short term debt is bank finance. It attempts to measure the extent to which a firm has to finance itself short term rather than long term and is therefore related to its access to long term finance. The higher the mix, the more-bank dependent a firm is. Thus, it is more likely to be characterised as a constrained firm. Following the same reasoning for young and small firms, more-bank dependent firms are expected to exhibit higher sensitivities to their *K/L* ratio. We create a dummy $BANK\ DEP_{it}$, which is equal to 1 if firm *i*'s mix is in the top 75 percent of the distribution of the mixes of all firms belonging to the same industry as firm *i* in year *t*, and

[7] Oliner and Rudebusch (1996) use a closely related variable (short term debt / total short term debt) in their test for the presence of a bank lending channel of transmission of monetary policy which has subsequently been used by Guariglia and Mateut (2006).

equal to 0 otherwise.

2.2. Data description and graphical analysis

We construct our data set from the profit and loss and balance sheet data gathered by Bureau Van Dijk Electronic Publishing in the FAME database. The FAME database provides information on 2.8 million companies, 1.9 million of which are in a detailed format, over the period 1994-2004.[8] Although detailed information are available for large firms, based on firms accounting thresholds refereed in the section 248 of the UK Companies Act 1985, small and medium enterprises (SMEs) do not report detailed accounts. For medium-sized companies there is no requirement to disclose turnover details, while for small-sized companies only an abridged balance sheet is required.

In contrast to earlier US and UK studies that employ datasets made up of quoted firms, we use a rich financial data which comprises mainly non-publicly traded firms. Our database includes a majority of firms which are not traded on the stock market or which are quoted on alternative exchanges such as the Alternative Investment Market (AIM) and the Off-Exchange (OFEX) market.[9] This is an appealing characteristic of the data as it allows our measures of capital market imperfections to display a wide degree of variation across observations in our sample. Having data on private as well as public companies is particularly valuable in our case, as the private companies are generally the smallest, youngest, and most-bank dependent firms. They are therefore more likely than public companies to face financial constraints.[10]

Our sample is limited only to firms that operate in the manufacturing sector. The decision to exclude all firms in service sector was taken for the following reasons:[11] The synthesis of the capital and the capital intensive nature of some of the manufacturing industries make them

[8] A maximum of 10 years of complete data history can be downloaded at once. Our data were downloaded early in 2005: the coverage period is therefore 1994-2004. It has to be noted that three types of access to the FAME dataset are available: type C gives access to all firms in the database; type B gives access to the top 322846 firms, and type A to the top 139901 firms. Only the latter access type was available to us for this paper.

[9] Unlike in the US, where only quoted firms are required to file their quarterly or annual accounts, UK firms have to disclose their accounts even if they are not traded on the stock market.

[10] Datasets that include only quoted firms, and therefore relatively large firms, are likely to be less informative in determining whether a firm is financially constrained or not. In contrast, our data include a large number of unquoted firms, 99.88 percent, and only a small fraction of quoted/publicly traded firms (0.12 percent).

[11] According to the Office for National Statistics (ONS), the service sector covers the wholesale and retail trades, hotels and restaurants, transport and communication, financial services, real estate and business activities and government and other services.

more suitable for the estimation of the *K/L* ratio. Further, the inclusion of services in our sample could bias the results due to the high likelihood of a severe measurement error of firms' capital stock. For firms operating in sectors like services the composition of capital is more likely to differ compared to that of firms in the manufacturing sector because intangible assets might prevail over the tangible assets.

We provide information on financial accounts and ratios for UK manufacturing firms for the years 1994-2004. Further, we use the STAN database as our source for data on industry level, alongside with FAME, to construct the user cost of capital. STAN is maintained by the Economic Analysis and Statistics Division of OECD's Directorate for Science, under the auspices of the Statistical Working Party of OECD's Committee on Industry and Business Environment. We extract information on investment and output at the industry level for all firms operating in the manufacturing sector.

Our sample includes 17,350 manufacturing firms and is representative of the aggregate economy along a number of dimensions. Figure 2 compares the aggregate percentage change of the number of employees for the firms in our panel with the corresponding percentage change for the OECD entire manufacturing sector. The two series are highly correlated and exhibit similar variation across time. They both present a sharp fall in 1997 and 2001 which is in line with findings in Nickell et al. (2005), who use data up to 2000 for OECD countries and show that the UK employment follows a decreasing trend between 1995 and 1997. According to the authors, a number of labour market institutions such as employment protection and employment taxes are found to affect negatively the employment rate. Accordingly, the drop in 2001 can be explained following the same argument.

Figure 3 compares the aggregate percentage change of firms' investment in our sample with the corresponding statistic for all manufacturing firms in OECD. The two measures paint a similar picture of the state of investment over time. Clearly evident is the sharp decline in investment between 1996 to 2000. Investment in our sample bottomed out at a very low level in 1996 and 2000 and then rose. The OECD investment line reached its lowest level in 2002 and ran-up in 2003. According to the Bank of England (2001) Financial Stability Review the decline in investment in 1996 and 2000 can be due to a number of factors such as the world economic downturn, the aftermath of the dotcom boom of the late 1990s, the decline in UK firm profitability that began in 1997 and the exchange rate appreciation.

Next, we impose the restriction that the firm has at least 3 consecutive time-series observations per company, with the number of years of observations on each firm varying between 4 and 11. This produces an unbalanced sample of manufacturing companies. By allowing for both entry and exit the use of an unbalanced panel partially mitigates potential selection and survivor bias. Finally, to control for the potential influence of outliers, observations in the variables that have very large dispersion are excluded. Hence, we start our empirical analysis with 14,700 firms.

The epicenter of this paper is the sensitivity of the *K/L* ratio to financial variables. Thus, an important element is the discussion of the capital stock and the number of employees which are used to construct the *K/L* ratio. Firms' simultaneous decisions on capital and on labour, and the substitutability of the two inputs create a motive to consider their evolution across time. Hence, it is of particular importance to show that any changes in the *K/L* ratio are not driven by changes in either capital stock (*K*) or the number of employees (*L*). Thus, we depict K and L variations over our sample period. Comparing Figures 4 and 5, we notice that both capital and labour follow a similar pattern across time. They both exhibit an increasing trend, although capital is rising at a higher pace during the mid to late 90's. Between 1999-2001 we witness first a rise and then a drop in both series, even though it is sharper for the capital stock, which is in line with the change in investment for the OECD line. The rise in capital can be justified by the boom in mergers and acquisitions between 1999 and 2001, the rise in the capital gearing by historical standards and the interest rate fall in 2000 that lead to the increase in capital (see Brierley and Bunn (2005)). As for the substantial drop in employment in 1995, this can be due to a number of labour market institutions mentioned earlier.[12] These figures tell us that both capital and labour change over time providing therefore justification for their joint examination.

We then consider the mean of leverage, collateral, cash flow and interest burden for more or less constrained firms using size as sorting device. Leverage, which is defined as the ratio of firms' total liabilities to total assets, is higher for small firms throughout our sample (Figure 6).

[12] These arguments can explain the peak in the *K/L* ratio in 2000 as shown in Figure 1.

This implies that high levels of existing debt are associated with worse balance sheet situation, which would increase moral hazard and adverse selection problems, and lead to the inability of firms to obtain external finance at a reasonable cost. Moving to cash flow (Figure 7), it is clear that small firms have a higher cash flow position in contrast to large firms. This may indicate that financially constrained firms feel the pressure to maintain a positive cash flow cushion under capital market imperfections. The ratio of tangible assets over firm's total assets (collateral ratio) for small and large firms is presented in Figure 8. We observe that the level of collateral is consistently higher for large firms compared to the small ones. It follows that large firms can pledge more tangible assets as collateral and therefore might find it easier to access capital markets. In general, we notice that all financial variables follow a decreasing trend for all groups of firms. One possible explanation for this pattern may be the slowdown in US growth which in turn affected the financial characteristics of UK firms directly through their activity in the US and indirectly through lower demand in the UK (Bank of England (2001)). The last figure depicts the evolution of interest burden (interest payments over total debt) which remains reasonably stable over time. Clearly, small firms have higher interest payment obligations compared to large firms which is consistent with the story that more financially constrained firms have to pay more to attract external funds.[13]

A very similar picture emerges by looking at the descriptive statistics in Table 1. Means and standard deviations of the firm-specific characteristics are reported for the entire sample (column 1) and for sub-samples (columns 2-3, 5-6, 8-9). Further, the p-values of a test for the equality of means are presented in columns 4, 7 and 10. Overall, firms that are less likely to be characterised as constrained (large, old, less-bank dependent) have higher values of real sales, real assets, capital-labour ratio and price. Turning to the financial variables we see that cash flow, leverage and collateral present similarities with the above analysed figures. More precisely, small, young and more-bank dependent firms have higher levels of cash flow, leverage and interest payment obligations whereas they are less collateralized. These differences between more or less financially constrained firms are statistically significant in all but two cases.

[13] To check the robustness of the figures presented above, we partition firms on the basis of age and bank dependency. We conclude that similar patterns are observed across different measures of constraints.

3. Methodology

This section describes the empirical approach and presents the baseline models. To examine the sensitivity of the *K/L* ratio to firm-specific characteristics we estimate the following static linear model.

$$y_{it} = X_{it}\beta + F_{it}\gamma + e_{it} \tag{1}$$

where $i = 1, 2, \ldots, N$ refers to a cross-section of firms, $t = 1, 2, \ldots, T$ refers to time period. y_{it} and X_{it} are the dependent variable and the vector of non financial explanatory variables for the firm *i* and year *t*, respectively. The dependent variable is the log of capital-labour ratio (K/L), where *K* is the tangible fixed assets and *L* is the number of employees.[14] The vector of non financial variables consists of $PRICE$ and $SALES$. The former is the log of real price - the ratio of industry variable user cost of capital to average firm wages.[15] This variable is aimed at controlling for changes in the price of factor inputs (capital and labour). We should expect the *K/L* ratio to be negatively affected by fluctuations in factor prices. When capital or labour become more expensive firms' decisions on the *K/L* ratio may be altered. The latter non financial variable is the log of real sales.[16] We augment our equation with the firm's sales to control for the potential scale effect i.e. for increasing or decreasing returns to scale. According to empirical evidence provided by Leung and Yuen (2005), the negative effect of sales in the short run is to be expected, because adjustment costs associated with labour should be less than those for capital. A rise in output is achieved initially through the use of more labour. Thus, it is anticipated a negative relationship between sales and the *K/L* ratio. e_{it}, is the error term made up of five components: ψ_i is a firm-specific component, ψ_t is a time-specific component accounting for business cycle effects, ψ_j is an industry-specific component accounting for industry dynamics, ψ_{jt} is an industry specific component which varies across time and accounts for industry-specific shifts across the time period, lastly ϵ_{it} is an idiosyncratic

[14] Following Konings et al. (2003), we use tangible fixed assets as a proxy for capital stock. In section 5 we test the robustness of our results by replacing tangible assets with the replacement value of capital stock.

[15] Although firm wages are affected by employee skills, we are unable to use this information since the FAME dataset has only information on the total employee remuneration.

[16] Nickell and Nicolitsas (1999) use a standard labour demand model, supplemented with a financial variable and a control for firm output namely the log of real sales.

component.[17] We control for ψ_i and ψ_j by estimating our equations in first-differences, for ψ_t by including time dummies, and for ψ_{jt} by including time dummies interacted with industry dummies in all our specifications.

The last variable of equation (1), F_{it}, denotes the vector of financial variables for the firm *i* and year *t*. The set of financial variables that we incorporate in our models is in line with the existing empirical literature. More precisely, we define $COLLATERAL$ as the ratio of tangible assets to total assets. An extensive body of the literature points out the importance of collateral for debt finance. Firms can raise external finance by pledging the underlying productive assets as collateral. Assets that are more tangible, sustain in fact more external financing because tangibility increases the value that can be recaptured by creditors in case of borrower's default. If the firm reneges on its debt, creditors will seize those assets (Carpenter and Petersen (2002) and Almeida et al. (2004)). We should expect collateral to be a significant indicator for constrained firms' *K/L* ratio.

We also employ $LEVERAGE$ defined as the ratio of total liabilities to total assets, as a measure of firms' indebtness. We aim at producing a comprehensive measure of the overall "tightness" of the firm's balance sheet (Sharpe (1994); Guariglia (1999) and Vermeulen (2002)). We might expect that highly leveraged firms i.e the financially vulnerable firms that face high agency costs and high levels of capital constraints, to present a more sensitive *K/L* ratio.

We include $CASHFLOW$, defined as the sum of after tax profit and depreciation normalised by the total assets of the company. Recent studies show that the activities of more constrained firms depend on the internal funds such as cash flow (Fazzari et al. (1988) and Guariglia (2008)), and suggest that only financially constrained firms should display a propensity to save cash (Almeida et al. (2004)). In this paper, we might expect cash flow to be less significant for financially unconstrained firms' *K/L* ratio. But on the other extreme, constrained firms should be eager to retain cash flow thus, implying its significance on firms' decisions on the *K/L* ratio.

[17] Firms are allocated to one of the following nine industrial groups: food, drink and tobacco; textiles, clothing, leather and footwear; chemicals and man made fibres; other minerals and mineral products; metal and metal goods; electrical and instrument engineering; motor vehicles and parts, other transport equipment; mechanical engineering; and others (Blundell et al. (1992)).

Finally, interest burden, IB, is incorporated in our model as an indicator for the firm-specific interest rate and is defined as the ratio of interest payment to total debt. Following previous studies (Benito and Whitley (2003) and Mojon et al. (2002)) we employ interest burden to capture the effects of a change in debt-servicing costs on the *K/L* ratio.

To explore the sensitivity of firms' *K/L* ratio stemming from the interaction between imperfect capital markets and firm-specific characteristics, we employ a set of dummy variables.

$$y_{it} = X_{it}\beta + F_{it}D_{it}\gamma + F_{it}(1 - D_{it})\delta + e_{it} \tag{2}$$

The dummy vector (D_{it}) is interacted with the vector of financial variables (F_{it}) in our baseline specification. The dummy vector consists of three different binary variables reflecting size, age and bank dependency.

In this paper we employ the First-Differenced GMM approach (see Arellano and Bond (1991)) which considers both the endogeneity bias and the unobserved heterogeneity problems.[18] The First-Differenced GMM states the equation in first differences to remove unobserved firm-specific and time-invariant industry-specific effects, while instrumenting the right hand side variables in the first-differenced equations by using the levels of the series involved, lagged by two or more periods. To test the validity of the additional instruments we use the GMM test of overidentifying restrictions, or Sargan/Hansen test. The *J* has an asymptotic chi-square distribution under the null that these moment conditions are valid. Further, to evaluate whether the model is correctly specified we use the *m2* test statistic to test the assumption that there is no second-order serial correlation in the first-differenced residuals.

4. Results

4.1. The nexus between firm-specific characteristics and the K/L ratio

A large and growing set of empirical findings (see Benito and Hernando (2007) and Guariglia (2008)) stress the importance of firm-specific indicators on fixed investment decisions, inventory investment, and employment. Taking into consideration earlier evidence, we seek to

[18] The choice of the First-Differenced GMM over the System-GMM is explained in section 5.

test whether firm-specific characteristics and the firm-specific interest rate are important determinants of the *K/L* ratio for UK firms.

Results are presented in Table 2. The coefficients on the control variables have the expected sign. Both *PRICE* (the ratio of factor prices) and *SALES* have a negative and highly significant effect on the dependent variable. Increasing price and sales by 1 percent results in 0.760 percent and 0.635 percent decrease in the capital-labour ratio respectively. When the prices of capital and labour increase the *K/L* ratio is affected negatively. Additionally, the negative relationship between sales and the *K/L* ratio might be explained by the use of more labour.

Turning to the analysis of the financial variables, the results indicate a significant effect of the covariates on the *K/L* ratio. In particular, the coefficient on *CASH FLOW* exerts a negative (-0.301) and significant impact on the *K/L* ratio. An increase in cash flow is associated with a decrease in the *K/L* ratio, perhaps due to firms' decision to use their internal funds mainly on employment rather than capital investment. This would be the case if firms were considered as relatively more constrained.[19] To see whether our financial variables have a quantitatively significant effect on the firm's *K/L* ratio we calculate and present their elasticities in Table 2.[20] An increase in cash flow causes the *K/L* ratio to drop with the elasticity at the mean being 0.078- a 10 percent increase in cash flow leads to a 0.78 percent decrease in the *K/L* ratio. The coefficient on *LEVERAGE* is negative (-0.859) suggesting that an increase in firms' debt limit affects negatively the *K/L* ratio. Firms exhibiting high levels of debt may face problems in attracting external funds to finance their projects. The elasticity of the *K/L* ratio with respect to leverage, evaluated at sample means, is 0.135. A 10 percent increase in leverage results a 1.35 percent drop in the *K/L* ratio. Next, *COLLATERAL* exhibits a positive and highly significant coefficient (2.547) stressing the importance of the ratio of tangible assets to total assets to support borrowing. A 10 percent increase in collateral is associated with 6.59 percent increase in the *K/L* ratio. Finally, the coefficient on interest burden, *IB*, is negative (-1.920) and highly

[19] This result could be attributed to the fact that the majority of firms included in the dataset are unquoted, which are more likely to be financially constrained. We elaborate on the issue of the interaction between cash flow and constraints in the next section.

[20] Elasticities can be calculated in four different forms: i) $d(lny)/d(lnx)$=β, ii) $d(lny)/d(x)$=β*$mean(x)$, iii) $d(y)/d(x)$=β*$mean(x)$/$mean(y)$, iv) $d(y)/d(lnx)$=β/$mean(y)$. Given that the dependent variable is measured in log, it is appropriate to calculate elasticities using formula (ii). The coefficients on the financial variables (cash flow, leverage, collateral) and the firm-specific interest rate are multiplied with their means in order to extract the elasticities.

significant: interest burden clearly has information about differences in payment obligations among firms embedded in it.[21] An increase in interest burden causes the *K/L* ratio to drop with the elasticity being 0.100.

Our instrument set includes collateral, leverage, cash flow, interest burden, price and sales all lagged two, three and four times. The J statistic has a significance of 0.343 and the $m2$ statistic shows no sign of second order serial correlation of the residual. Both tests suggest that the instruments are valid and that there is no sign of mis-specification in the model. The results obtained from this specification are of particular importance in shaping the view that firm-specific characteristics such as leverage, collateral and cash flow and the firm-specific interest rate are important determinants of the *K/L* ratio.

4.2. Capital market imperfections and the K/L ratio

In this section, motivated by the existing investment and employment literature we consider the effects of financial factors on both investment and hiring decisions by investigating how more or less financially constrained firms allocate their funds when decisions on capital and on labour have to be taken simultaneously. In particular, we examine whether more financially constrained firms are likely to face a higher sensitivity of the *K/L* ratio to firm-specific indicators compared to their less constrained counterparts. Further, our aim is to exploit heterogeneity at the firm level in order to consider the financial-accelerator hypothesis, that deteriorations in financial health increase the cost of finance, and hence to show that the *K/L* ratio of financially constrained firms is affected more severely.

To examine our main hypotheses we follow the established empirical financial constrains literature and divide firms to more and less constrained using different classification criteria such as size, age and bank dependency. The results are remarkably consistent across these categories and document that constrained firms exhibit greater sensitivities to the *K/L* ratio.[22] Table 3 reports the results from the interaction between firm type dummies and financial vari-

[21] A firm-specific estimate of the cost of debt (or firm-specific interest rate) has recently been employed by a number of studies (see Benito and Whitley (2003) and Mojon et al. (2002)). They present evidence that firms' real and financial decisions are influenced through the firm-specific interest rate. Their findings support the notion that debt-servicing costs affect not only investment expenditures but also employment and inventory spending.

[22] We split firms to more or less financially constrained using the 75 percent cut-off value. We explore the robustness of this finding in section 5.

ables as reported in equation (2).

To start with, a key result concerns the impact of *CASH FLOW* on the *K/L* ratio. The coefficient on cash flow for small firms is negative (-0.356) and statistically significant, indicating a negative correlation between cash flow and the *K/L* ratio. Looking at columns (2) and (3) we see that the coefficients on cash flow for young (-0.363) and more-bank dependent (-0.361) firms display similar sign and magnitude compared to small firms. When a firm faces difficulties in obtaining external finance its employment should be more sensitive to the availability of its internal funds. Constrained firms can not invest optimally in capital due to some technological impediment to adjusting capital quickly (this will be the case if capital investment is lumpy as suggested in the investment literature) thus the firm will satisfy demand using labour more intensively.[23] This finding shows that a 10 percent increase in cash flow for small firms causes the *K/L* ratio to drop by 1.01 percent. The analogous figures for young and more-bank dependent firms are 0.98 and 0.94, respectively. For unconstrained firms the coefficients are insignificant and quantitatively unimportant implying that the cash flow-*K/L* ratio correlation is zero. Table 3 also reports p-values related with the F-test for the equality of the coefficients on the interacted terms across the three firm classes. The results show that the coefficients on cash flow for more constrained firms are significantly different from the coefficients of less constrained firms.

Next, we observe the negative impact of *LEVERAGE* on the *K/L* ratio which is significant for constrained firms. More precisely, focusing on column (1) we see that the coefficient on leverage is negative (-0.473) for small firms. Respectively, the coefficients on leverage for young (-0.598) and more-bank dependent (-0.624) firms exert a negative impact on the *K/L* ratio. This result is consistent with the view that higher levels of debt may deter creditors from offering further credit for firms that are vulnerable, meaning a limited access on external finance for more constrained firms. It is a stylised fact that firms have to raise external finance

[23] Anecdotal evidence in Spaliara (2008) suggests that the sign of cash flow varies with the industry under consideration. Cash flow has a positive impact on the *K/L* ratio for the constrained group of firms operating in high-tech industries. These are electrical and instrument engineering; motor vehicles and parts, other transport equipment; mechanical engineering. Due to their high technology profile, firms retain cash flow as a buffer stock to invest mainly on capital. However, a sign reversal is observed for constrained firms in low-tech industries i.e food, drink and tobacco; textiles, clothing, leather and footwear; and miscellaneous industries. This result may be attributed to the labour intensive character of low-tech industries. The majority of firms in our sample operate in low-tech industries and this might influence the negative sign of cash flow observed in Table 3.

in order to finance their investment projects. However, when a firm is highly indebted it's extremely difficult and expensive to obtain outside finance. Thus, the higher the debt burden, the higher is the cost of external finance. Cantor (1990) and Calomiris et al. (1994) show that increases in leverage at the firm level are associated with increased volatility in capital expenditures. In other words, financially constrained firms with high level of leverage are more likely to face a more sensitive *K/L* ratio. The elasticities evaluated at sample means suggest that a 10 percent rise in leverage is related with 0.90 percent decrease in the *K/L* ratio for small firms. The corresponding figures for firms classified as young and more-bank dependent are 1.12 percent and 1.13 percent. Once again, the elasticities are consistent across firm classes. On the other hand, the coefficients on leverage for the less constrained group of firms appear to be insignificant for all three firm classes. The p-values reveal that in all three cases the coefficients on leverage for the constrained group of firms are statistically different from those of the unconstrained ones.

Turning to *COLLATERAL*, the estimated coefficients are positive and significant for both constrained and unconstrained firms. Thus, it seems that the importance of collateralized assets for debt finance is a critical indicator for firms' decisions on their *K/L* ratio. These results are in line with Berger and Udell (1990) who show that collateral is an important factor reducing the riskiness of a loan by giving the financial institution a claim on a tangible asset. Contrary to our expectations the coefficients on collateral are mainly higher for unconstrained firms. The elasticities of the *K/L* ratio to collateral range between 0.635 to 0.716 for constrained firms, while they are between 0.860 and 0.947 for unconstrained firms. However, when we look at the p-values we observe that they are not significantly different from each other suggesting that the effects of the collateral are the same across different groups of firms.

Our results, presented in Table 2, thus far imply that interest burden (IB) has a negative and significant impact on the *K/L* ratio. Although this indicator is not controlled exogenously by the Bank of England (it is endogenous in the sense that it reflects the financial conditions of firms as well as the interest rate), it does provide evidence about the extent of the asymmetric information problem in the financial transactions given firm heterogeneity (Bougheas et al. (2006)). The coefficients associated with the interacted interest burden show evidence that the

K/L ratio of constrained firms is more sensitive compared to their unconstrained counterparts. Specifically, in columns (1), (2) and (3) the coefficients on interest burden for all groups of firms exhibit a negative and precisely determined effect on the *K/L* ratio. This may be due to increases in the cost of finance for the more constrained firms. This effect is economically significant since a 10 percent increase in interest burden is associated with 0.92 percent decrease in the *K/L* ratio for firms categorised as small. Similar elasticities are observed for the remaining two classification schemes. As for the F-test for the equality, it shows that the coefficients on interest burden display significant differences in all cases.

The instrument set includes the interaction of collateral, leverage, cash flow and interest burden with the size, age and bank dependency dummies, and price, sales all lagged two, three and four times. Overall, the *J* and *m2* tests do not indicate any problems with the specification of the model and the choice of the instruments.

Summarizing our results, we find that the *K/L* ratio presents a higher response to fluctuations in cash flow, leverage and interest burden for firms that are more likely to face financial constraints. In particular, equation (2) estimates provide us with evidence that firms facing a different degree of credit constraints exhibit heterogeneous responses of the *K/L* ratio. In other words, more constrained firms exhibit greater sensitivities of the capital-labour ratio to financial variables.

5. Robustness checks

In this section we provide a series of robustness analysis of our results. Firstly, we examine whether our results remain persistent when we employ a dynamic estimation. Secondly, we re-estimate our models replacing our capital stock variable, tangible fixed assets, with the replacement value of capital stock. Thirdly, we split our sample using alternative cut-off values to check the persistence of our results. Finally, to test the robustness of the cash flow results, we regress the models excluding the distressed firms.

5.1. Dynamic estimation

The rationale for estimating our models in a dynamic panel data setting, can be attributed to the time lags that we should expect capital adjustment to be subject to. Given the speed and the time of capital and labour adjustment, we estimate our models employing a dynamic approach.

All our variables retain their sign and significance in most of the cases while the results support the validity of the instruments and the absence of second-order serial correlation. In Table 4 we present the estimated results of equations (1) and (2). The main findings from the Dynamic First-Differenced GMM estimations are in line with those reported in section 4.[24] It is confirmed that firm-specific characteristics such as leverage, collateral and cash flow and the firm-specific interest rate are important determinants of the *K/L* ratio. Furthermore, when we make the distinction between more or less financially constrained firms we show that the former group of firms exhibits higher sensitivities of the *K/L* ratio to cash flow and leverage. Moreover, the capital-labour ratio is more sensitive to the implicit interest rate for constrained firms confirming that financial accelerator phenomena play an important role in the transmission mechanism of monetary policy for the UK. The elasticities are presented in Table 8. They suggest that the percentage change of the *K/L* ratio is somewhat smaller compared to the changes presented in Table 3. In particular, for the small group of firms a 10 percent increase in cash flow and leverage is related with 0.61 percent and 0.62 percent drop in the *K/L* ratio. The figures for the remaining two classification schemes, presented in columns (3) and (4), paint a similar picture. Next, the elasticities of the *K/L* ratio to collateral range between 0.492 and 0.652 for constrained firms, while they are between 0.731 and 0.910 for their unconstrained counterparts. Finally, a 10 percent rise in the interest burden leads to a 0.6, 0.73 and 0.81 percent drop in the *K/L* ratio for more constrained firms. Overall, the p-values of the F-test on cash flow, leverage and interest burden show significant differences among firm

[24] A recently developed model is the System-GMM, an augmented version of First-Differenced GMM outlined in Arellano and Bover (1995) and fully developed in Blundell and Bond (1998). The system-GMM controls for fixed effects with the estimator being an extension of the GMM estimator of Arellano and Bond (1991) and estimates equations in levels as well as in first-differences. Estimating the levels equations with a lagged difference term as an instrument offers significant gains, countering the bias associated with weak instruments (Blundell and Bond (1998)). System-GMM performs better than First-Differenced GMM with the latter being seriously biased in small samples when the instruments are weak. A way to detect whether the First-Differenced GMM estimator is affected by the finite sample biases is to compare the estimate of the coefficient on the lagged dependent variable obtained from the latter estimator with those obtained form the OLS and the WG estimators. As the OLS estimate is upward biased, whereas the WG estimate is downward biased, one would expect a consistent estimate of the coefficient on the lagged dependent variable to lie in between these two estimates. If we find that the estimate obtained using the First-Differenced GMM estimator lies close or below the WG estimated, then the GMM estimate is downward biased as well (see Bond et al. (2001)). After estimating equation (1) using the OLS, the WG and the First-Differenced GMM estimators, we find that the GMM coefficient lies between the OLS and the WG estimates. We can conclude that the First-Differenced GMM estimates are unlikely to be subject to serious finite sample biases, thus, we opt for estimating the model using the First-Differenced GMM.

classes but this is not the case for collateral.

5.2. An alternative measure of capital stock

Since part of our analysis depends on the capital-labour ratio, it is important to check whether our results hinge on how finely we construct capital. Up to this point we have used tangible fixed assets as the firm's capital stock. Although it is common in the investment literature (Blundell et al. (1992)) to use the replacement value of capital stock we prefer to employ it as a measure of robustness rather than our main capital variable for one important consideration. This approach may be problematic in short samples, as it causes a considerable loss of observations. In fact, when we construct the replacement value of capital stock using the perpetual inventory formula we loose a substantial number of observations. After re-estimating equations (1) and (2) we show in Table 5 that results remain largely unchanged, compared with those obtained using the tangible assets as our preferred capital variable (Tables 2 and 3), and quantitatively significant. The elasticities of the *K/L* ratio with respect to financial variables are presented in Table 8. Thus, these findings provide assurance that our main results are not affected by the definition of capital.

5.3. Alternative cut-off values

As presented in section 2, due to the synthesis of our data we use a 75 percent cut-off point to better depict capital market imperfections. To test the robustness of our results we use the same criteria for splitting our sample between firms that are more and less likely to face financial constraints, but different cut-off values. In particular, to make sure that our results are not driven from the way that we divide our sample, we employ an alternative benchmark level, namely 50 percent. Comparing our results in Table 6 with those shown in Table 3 we observe that our findings are very similar both quantitatively and qualitatively for all three measures. We can conclude that the results discussed in section 4 are not biased due to the selection of cut-off values.

5.4. Positive cash-flow observations and the K/L ratio

One aim of the paper is to show the sensitivity of the *K/L* ratio to firm-specific characteristics i.e cash flow, leverage and collateral. Hence, it is important to verify that the inclusion of the distressed firms, as proxied by negative cash flow observations, do not lower the quantitative significant effect of cash flow on the *K/L* ratio. To examine whether our findings on cash flow-*K/L* ratio relationship are driven by the fact that a firm is in sufficiently bad shape, we follow Allayannis and Mozumbar's (2004) technique and we exclude from our sample all the negative cash flow observations.[25]

Negative cash flow observations account for 12 percent of the total cash flow observations and by excluding them we can compare our results across two dimensions: i) the scale of coefficients and ii) their corresponding elasticities. Results are presented in Tables 7 and 8 and should be compared with those in Tables 2 and 3. The coefficients and elasticities associated with the cash flow variable are now higher in all cases. The impact of cash flow on the *K/L* ratio remains negative and highly significant only for the group of constrained firms as before. Precisely, the coefficients for small/young/more-bank dependent firms are now -0.391, -0.397 and -0.430 and the elasticities of the *K/L* ratio are 0.129, 0.131 and 0.136. This result is in line with the finding from Allayannis and Mozumdar (2004) and Guariglia (2008) and shows that the excluded negative cash flow observations have lower *K/L*-cash flow sensitivities.

6. Conclusions

In this paper we use a large panel of financial data on UK firms, 99.8 percent of which are not quoted on the stock market, to examine how the *K/L* ratio should respond to fluctuations in cash flow, leverage and collateral for firms that are more or less likely to face financial constraints. Further, we focus on the direct effect of the firm-specific interest rate on the *K/L* ratio for more and less financially constrained firms. Using data on unquoted firms has provided us with a unique opportunity to construct measures of financial constraints displaying a wide degree of variation across observations.

[25] They investigate the role of negative cash flow observations on investment decisions estimating investment models including positive cash flow observations and all the cash flow observations interchangeably. They find that distressed firms exhibit lower investment-cash flow sensitivities than non-distressed firms.

This paper is motivated by the fact that relatively little attention has been devoted to the sensitivity of the *K/L* ratio to financial factors which is somewhat surprising given that changes in labour demand and fixed investment arise, to some extent, due to information problems in financial markets. We consider the effects of financial factors on both investment and hiring decisions in order to examine how more and less constrained firms allocate their funds on capital and on labour when decisions on both inputs have to be taken simultaneously.

The paper has found evidence that firms' balance sheet characteristics and the *K/L* ratio are interrelated. According to our results, firms' capital-labour ratio is affected by cash flow, leverage, collateral and interest burden. Further, when firms are classified on the basis of their size, age and bank dependency, we show that financially constrained firms face a greater sensitivity of the capital-labour ratio in contrast to unconstrained firms. We also find evidence that the K/L ratio is negatively associated with the firm-specific interest rate, as measured by the interest burden, and is more sensitive for the constrained group of firms. Our results are robust to estimating our empirical models employing a Dynamic First-Differenced GMM approach, to replacing tangible fixed assets with the replacement value of capital stock, to using alternative cut-off values and to excluding distressed firms from our sample. The results suggest that financial factors strongly affect the *K/L* ratio in the UK manufacturing sector.

Our findings have important policy implications. A top priority for the UK authorities should be the promotion of financial policies that could spur growth in the economy by relaxing financial constraints. This is of particular importance for more financially constrained firms that face difficulties to expand due to the cost of finance. These policies become even more relevant during bad economic times since they can help constrained firms to avoid shortage of credit, and preserve jobs. Nevertheless, the above policies should be carefully scrutinised as might not be a panacea for all economies.

7. Appendix

7.1. Variable construction

7.1.1. Firm-level variables

- *Replacement value of capital stock* (*K*): It is constructed using the traditional perpetual inventory method Blundell et al. (1992). We use tangible fixed assets as the historic value of the capital stock. We assume that replacement cost and historic cost are the same in the first year of data for each firms. The perpetual inventory formula is calculated as follows

$$K_{t+1} = (1-\delta)K_t[\frac{P_{t+1}}{P_t}] + I_{t+1}$$

  where δ is the depreciation rate, which we assume to be constant and equal to 5.5% for all firms, P_t is the price of investment goods and I_t is the investment.

- *Capital stock* (*K*): Is the tangible fixed assets.
- *Employment* (*L*): Is given by the total number of employees.
- *Total sales* (*Sales*): Is the log of total company sales.
- *Cash flow*: Is defined as the sum of after tax profit and depreciation normalized on total assets of the company.
- *Leverage*: Is the ratio of total liabilities to total assets.
- *Collateral*: Is defined as the ratio of tangible assets to total assets.
- *Mix*: Is measured as the ratio of the firm's short-term debt to its total debt.
- Age: Is defined as the difference between the present year and the firm's date of incorporation.
- *Size*: Is the firm's total assets (sum of fixed assets and current assets).
- *Average firm wages* (*W*): Is given by the total employee remuneration divided by the number of employees.
- *User cost of capital* (*UC*): Based on the contribution by Hall and Jorgenson (1967), we construct the user cost of capital following Mojon et al. (2002)

$$UC_{j,t} = [\frac{P_{I,j,t}}{P_{j,t}}]\{(1-\tau)i_t[\frac{D_j}{D_j+E_j}] + b_t[\frac{E_j}{D_j+E_j}] + \delta_j - (1-\delta_j)[\frac{\Delta P_{I,j,t}}{P_{I,t}}]\}$$

where *j* indicates the number of industries in the manufacturing sector and *t* the time period. P_I*j*,*t* and $P_{j,t}$ are the industry specific prices of investment goods and output. τ is the highest marginal tax rate on corporate profits, i_t is the base rate (we prefer to use the base rate rather than a firm specific interest rate), b_t are yields on benchmark public sector bonds of around 10 years maturity, δ_j is the average depreciation rate in the particular industry. $D_j/D_j + E_j$ and $E_j/D_j + E_j$ are respectively the average percentage of debt finance and equity finance in the particular industry. $(1-\tau)i_t[D_j/(D_j+E_j)] + b_t[E_j/(D_j+E_j)]$ is the industry-specific required rate of return on capital and $(1-\delta)[\frac{\Delta P_{I,j,t}}{P_{I,t}}]$ the capital gain on the fraction of capital left over after depreciation.

- *Price*: Is the user cost of capital to average company wage in log.
- *Interest burden* (*IB*): Is the ratio of interest payments to total debt.
- *Outliers*: We trim 0.5 percent of observations both from above and the below to remove the outliers for our main variables.

7.1.2. Industry-level variables

- *Price of investment goods* ($P_{I,j,t}$): Is defined as the gross fixed capital formation.
- *Price of output* ($P_{j,t}$): Is given by the industry- specific output.
- *Deflators*: The capital stock is deflated using the industry specific price of investment goods. Other variables are deflated using the industry specific price of output.

References

Agca, S., Mozumbar, A., 2008. The impact of capital market imperfections on investment-cash flow sensitivity. Journal of Banking and Finance 32, 207-216.

Allayannis, G., Mozumdar, A., 2004. The impact of negative cash flow and influential observations on investment-cash flow sensitivity estimates. Journal of Banking and Finance 28, 901-930.

Almeida, H., Campello, M., Weisbach, M., 2004. The cash flow sensitivity of cash. Journal of Finance 59, 1777-1804.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. Review of Economic Studies 58, 277-297.

Arellano, M., Bover, O., 1995. Another look at the instrumental variable estimation of error-components models. Journal of Econometrics 68, 29-51.

Bank of England, 2001. The UK corporate and household sectors. Financial Stability Review, Bank of England.

Benito, A., Hernando, I., 2007. Firm behaviour and financial pressure: Evidence from Spanish panel data. Bulletin of Economic Research 59, 283-311.

Benito, A., Hernando, I., 2008. Labour demand, flexible contracts and financial factors: Firm-level evidence from Spain. Oxford Bulletin of Economics and Statistics 70, 283-301.

Benito, A., Whitley, J., 2003. Implicit interest rates and corporate balance sheets: An analysis using aggregate and disaggregated UK data. Working Paper 193, Bank of England.

Berger, A., Udell, G., 1990. Collateral, loan quality, and bank risk. Journal of Monetary Economics 25, 21-42.

Bernanke, B., Gertler, M., Gilchrist, S., 1999. The financial accelerator in a quantitative business cycle framework. In: Taylor, J., Woodford, M. (Eds), Handbook of Macroeconomics, Vol. 1C. Elsevier Science, North-Holland.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87, 115-143.

Blundell, R., Bond, S., Schiantarelli, F., 1992. Investment and Tobin's Q: Evidence from company panel data. Journal of Econometrics 51, 233-257.

Bond, S., Hoeffler, A., Temple, J., 2001. GMM estimation of empirical growth models. Working Paper 525, University of Bristol.

Bond, S., Van Reenen, J., 2006. Microeconometric models of investment and employment. In: Heckman J., Leamer E. (Eds), Handbook of Econometrics, Vol. 6, Elsevier, North-Holland.

Bougheas, S., Mizen, P., Yalcin, C., 2006. Access to external finance: Theory and evidence on the impact of firm-specific characteristics. Journal of Banking and Finance 30, 199-227.

Brierley, P., Bunn, P., 2005. The determination of UK corporate capital gearing. Quarterly Bulletin, Bank of England.

Brown, J., Petersen, B., 2009. Why has the investment-cash flow sensitivity declined so sharply? Rising R&D and equity market developments. Journal of Banking and Finance 33, 971-984.

Calomiris, C., Orphanides, A., Sharpe, S., 1994. Leverage as a state variable for employment, inventory accumulation and fixed investment. Working Paper 4800, NBER.

Campello, M., Graham, J., Harvey, C., 2008. The real effects of financial constraints: Evidence from a financial crisis. Working Paper 1318355, SSRN.

Cantor, R., 1990. Effects of leverage on corporate investment and hiring decisions. Quarterly Review 15, Federal Reserve Bank of New York.

Carpenter, R., Guariglia, A., 2008. Cash flow, investment, and investment opportunities: New tests using UK panel data. Journal of Banking and Finance 32, 1894-1906.

Carpenter, R., Petersen, B., 2002. Is the growth of small firms constrained by internal finance? Review of Economics and Statistics 84, 298-309.

Devereux, M., Schiantarelli, F., 1990. Investment, financial factors and cash flow: Evidence from UK panel data. In: Hubbard G. (Eds.), Information, Capital Market and Investment. Chicago, University of Chicago Press.

Fazzari, S., Hubbard, G., Petersen, B., 1988. Financing constraints and corporate investment. Brookings Papers on Economic Activity 2, 141-195.

Garmaise, M., 2008. Production in entrepreneurial firms: The effects of financial constraints on labor and capital. Review of Financial Studies 21, 543-577.

Gertler, M., Gilchrist, S., 1994. Monetary policy, business cycles, and the behavior of small manufacturing firms. Quarterly Journal of Economics 109, 309-340.

Greenaway, D., Guariglia, A., Kneller, R., 2007. Financial factors and exporting. Journal of International Economics 73, 377-395.

Guariglia, A., 1999. The effects of financial constraints on inventory investment: Evidence from a panel of UK firms. Economica 66, 43-62.

Guariglia, A., 2008. Internal financial constraints, external financial constraints, and investment choice: Evidence from a panel of UK firms. Journal of Banking and Finance 32, 1795-1809.

Guariglia, A., Mateut, S., 2006. Credit channel, trade credit channel, and inventory investment: Evidence from a panel of UK firms. Journal of Banking and Finance 30, 2835-2856.

Hall, R., Jorgenson, D., 1967. Tax policy and investment behavior. American Economic Review 57, 391-414.

Hubbard, G., 1998. Capital market imperfections and investment. Journal of Economic Literature 35, 193-225.

Kaplan, S., Zingales, L., 1997. Do investment-cash flow sensitivities provide useful measures of financial constraints? Quarterly Journal of Economics 112, 169-216.

Kashyap, A., Stein, J., Wilcox, D., 1993. Monetary policy and credit conditions: Evidence from the composition of external finance. American Economic Review 83, 78-98.

Konings, J., Rizov, M., Vandenbussche, H., 2003. Investment and financial constraints in transition economies: Micro evidence form Poland, the Czech Republic, Bulgaria, and Romania. Economics Letters 78, 253-258.

Leung, D., Yuen, T., 2005. Do exchange rates affect the capital-labour ratio? Panel evidence from Canadian manufacturing industries. Working Paper 12, Bank of Canada.

Mojon, B., Smets, F., Vermeulen, P., 2002. Investment and monetary policy in the Euro area. Journal of Banking and Finance 26, 2111-2129.

Nickell, S., Nicolitsas, D., 1999. How does financial pressure affect firms? European Economic Review 43, 1435-1456.

Nickell, S., Nunziata, L., Ochel, W., 2005. Unemployment in the OECD since the 1960s. What do we know? Economic Journal 115, 1-27.

Oliner, S., Rudebusch, G., 1996. Monetary policy and credit conditions: Evidence from the composition of external finance: Comment. American Economic Review 86, 300-309.

Sharpe, S., 1994. Financial market imperfections, firm leverage, and the cyclicality of employment. American Economic Review 84, 1060-1074.

Spaliara, M., 2008. Financial constraints, K/L ratio, and the elasticity of substitution in the UK: Evidence from micro data, Mimeograph, Loughborough University.

Tirole, J., 2006. The Theory of Corporate Finance. Princeton University Press.

Vermeulen, P., 2002. Business fixed investment: Evidence of a financial accelerator in Europe. Oxford Bulletin of Economics and Statistics 64, 217-235.

von Kalckreuth, U., 2006. Financial constraints and capacity adjustment: Evidence from a large panel of survey data. Economica 73, 691-724.

Acknowledgments

I acknowledge constructive comments from an anonymous referee, the editor (Ike Mathur), Spiros Bougheas, Charles Calomiris, Sourafel Girma, Holger Görg, Chris Green, Alessandra Guariglia, Max Hall, Aofie Hanley, Simona Mateut, Paul Mizen, Simon Price, John Tsoukalas and Serafeim Tsoukas. I would also like to thank Manuel Arellano, Christopher Baum and Steve Bond for helpful suggestions on the econometric methodology employed. Participants at the 23rd EEA meeting in Milan, the 2007 RES conference in Warwick, the 40th MMF conference in Birkbeck, the ONS virtual microdata laboratory quarterly workshop in London, the 2nd Italian congress in econometrics in Bologna and the 6th GEP conference in Nottingham, also made beneficial comments.

Table 1: Descriptive statistics

	ALL FIRMS	SMALL$_{it}$=0	SMALL$_{it}$=1	Diff.	YOUNG$_{it}$=0	YOUNG$_{it}$=1	Diff.	BANK DEP$_{it}$=0	BANK DEP$_{it}$=1	Diff.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$(K/L)_{it}$	0.159	0.221	0.131	0.000	0.159	0.160	0.982	0.195	0.153	0.000
	(0.211)	(0.260)	(0.177)		(0.201)	(0.215)		(0.234)	(0.206)	
$Price_{it}$	2.105	2.153	2.077	0.029	2.12	2.099	0.561	1.984	2.123	0.006
	(4.493)	(6.350)	(2.885)		(2.883)	(5.027)		(1.696)	(4.764)	
$RealSales_{it}$	120.928	220.77	49.881	0.000	158.795	105.926	0.000	132.326	119.430	0.000
	(216.294)	(298.349)	(67.788)		(258.096)	(195.284)		(222.732)	(215.390)	
$RealAssets_{it}$	69.321	205.219	23.936	0.000	97.241	59.118	0.000	90.016	66.352	0.000
	(136.46)	(219.507)	(22.843)		(171.346)	(119.619)		(162.799)	(131.987)	
Age_{it}	24.549	25.761	23.830	0.000	55.536	13.951	0.000	23.338	24.692	0.000
	(22.201)	(24.834)	(20.442)		(19.088)	(9.803)		(22.356)	(22.178)	
Mix_{it}	50.693	48.300	51.565	0.000	50.313	51.869	0.000	16.417	62.074	0.000
	(25.887)	(27.808)	(25.094)		(25.764)	(26.284)		(8.648)	(18.66)	
$CashFlow_{it}$	0.259	0.219	0.285	0.000	0.231	0.271	0.000	0.242	0.262	0.000
	(0.407)	(0.350)	(0.427)		(0.358)	(0.425)		(0.379)	(0.411)	
$Leverage_{it}$	0.175	0.129	0.190	0.000	0.144	0.187	0.000	0.138	0.181	0.000
	(0.156)	(0.108)	(0.166)		(0.120)	(0.166)		(0.110)	(0.161)	
$Collateral_{it}$	0.295	0.313	0.292	0.000	0.308	0.290	0.000	0.376	0.282	0.000
	(0.188)	(0.185)	(0.189)		(0.183)	(0.190)		(0.191)	(0.185)	
IB_{it}	0.052	0.039	0.057	0.000	0.047	0.054	0.000	0.048	0.053	0.000
	(0.073)	(0.059)	(0.077)		(0.069)	(0.074)		(0.068)	(0.074)	
Observations	38745	10900	27845		10166	28579		9221	29524	

Notes: The table presents sample means. Standard deviations are reported in parentheses. Diff. is the p-value of the test statistic for the equality of means. The subscript *i* indexes firms, and the subscript *t*, time, where *t* = 1994-2004. $SMALL_{it}$ is equal to 1 for firms in the bottom 75% of their real assets distribution in year *t*, and 0, otherwise. $YOUNG_{it}$ is equal to 1 for firms in the lower 75% of their age distribution in year *t*, and 0, otherwise. $BANK\ DEP_{it}$ is equal to 1 for firms in the top 75% of their mix distribution in year *t*, and 0, otherwise. $(K/L)_{it}$: Capital over labour, $Price_{it}$: User cost of capital to average firm wages, Mix_{it}: Short term debt over total debt, $Leverage_{it}$: Total liabilities to total assets, $Collateral_{it}$: Tangible assets to total assets, $CashFlow_{it}$: Sum of after tax profit and depreciation on total assets, IB_{it}: Interest payments to total debt. Variables are measured in thousands of pounds. See appendix for detailed definitions of variables.

Table 2: Firm-specific characteristics and the *K/L* ratio

	GMM
$Price_{it}$	-0.760***
	(-4.01)
$Sales_{it}$	-0.635***
	(-6.57)
$CashFlow_{it}$	-0.301***
	(-3.64)
$Leverage_{it}$	-0.859**
	(-2.48)
$Collateral_{it}$	2.547***
	(7.54)
IB_{it}	-1.920***
	(-4.15)
Elasticities	
$CashFlow_{it}$	0.078
$Leverage_{it}$	0.135
$Collateral_{it}$	0.659
IB_{it}	0.100
$JStatistic$	0.343
$m2$	0.253
$Instruments$	t-2; t-3; t-4

Notes: Dependent variable is log(capital/labour). All specifications were estimated using the GMM first-differenced specification. The figures reported in parentheses are t-statistics in absolute values. * significant at 10%; ** significant at 5%; *** significant at 1%. Time dummies and time dummies interacted with industry dummies were included in all specifications. Numbers of firms and of observations are 4520 and 14125, respectively. $m2$ is a test for second-order serial correlation in the first-differenced residuals, and the J statistic is a test of the overidentifying restrictions. Also the elasticities of the dependent variable with respect to financial indicators are presented. See notes to Table 1.

Table 3: Capital market imperfections and the *K/L* ratio

	Constrained= $SMALL_{it}$	Constrained= $YOUNG_{it}$	Constrained= $BANK\ DEP_{it}$
	GMM	GMM	GMM
	(1)	(2)	(3)
$Price_{it}$	-0.498***	-0.514***	-0.671***
	(-4.37)	(-4.01)	(-4.45)
$Sales_{it}$	-0.666***	-0.634***	-0.711***
	(-17.63)	(-15.62)	(-15.99)
$CashFlow_{it} * Constrained_{it}$	-0.356***	-0.363***	-0.361***
	(-5.36)	(-5.49)	(-5.04)
$CashFlow_{it} * (1 - Constrained_{it})$	0.022	0.038	-0.048
	(0.54)	(1.07)	(-0.81)
$Leverage_{it} * Constrained_{it}$	-0.473*	-0.598**	-0.624*
	(-1.77)	(-1.97)	(-1.89)
$Leverage_{it} * (1 - Constrained_{it})$	-0.162	-0.041	-0.304
	(-0.53)	(-0.09)	(-0.54)
$Collateral_{it} * Constrained_{it}$	2.221***	2.473***	2.253***
	(5.34)	(5.90)	(5.05)
$Collateral_{it} * (1 - Constrained_{it})$	2.851***	2.796***	2.522***
	(7.22)	(5.75)	(4.73)
$IB_{it} * Constrained_{it}$	-1.632***	-1.923***	-1.233***
	(-3.46)	(-4.06)	(-3.09)
$IB_{it} * (1 - Constrained_{it})$	0.047	-0.534	-0.720***
	(0.09)	(-1.33)	(-3.67)
Elasticities			
$CashFlow_{it} * Constrained_{it}$	0.101	0.098	0.094
$CashFlow_{it} * (1 - Constrained_{it})$	0.004	0.008	0.011
$Leverage_{it} * Constrained_{it}$	0.090	0.112	0.113
$Leverage_{it} * (1 - Constrained_{it})$	0.021	0.006	0.042
$Collateral_{it} * Constrained_{it}$	0.648	0.716	0.635
$Collateral_{it} * (1 - Constrained_{it})$	0.892	0.860	0.947
$IB_{it} * Constrained_{it}$	0.092	0.103	0.065
$IB_{it} * (1 - Constrained_{it})$	0.001	0.025	0.034
F-test of equality			
$CashFlow_{it}$	0.000	0.000	0.000
$Leverage_{it}$	0.000	0.000	0.000
$Collateral_{it}$	0.095	0.528	0.500
IB_{it}	0.003	0.008	0.096
$JStatistic$	0.139	0.057	0.054
$m2$	0.183	0.059	0.220
$Instruments$	t-2; t-3; t-4	t-2; t-3; t-4	t-2; t-3; t-4

Notes: Dependent variable is log(capital/labour). All specifications were estimated using the GMM first-differenced specification. The figures reported in parentheses are t-statistics in absolute values. * significant at 10%; ** significant at 5%; *** significant at 1%. Time dummies and time dummies interacted with industry dummies were included in all specifications. Constrained is a dummy variable that represents $SMALL_{it}, YOUNG_{it}, BANK\ DEP_{it}$. Numbers of firms and of observations are 4520 and 14125, respectively. $m2$ is a test for second-order serial correlation in the first-differenced residuals, and the J statistic is a test of the overidentifying restrictions. The elasticities of the dependent variable with respect to financial indicators are presented for each firm type along with the F-test for the equality of the coefficients. Also see notes to Table 1.

Table 4: Robustness: dynamic estimation of capital market imperfections and the *K/L* ratio

	ALL FIRM-YEARS	Constrained= SMALL_{it}	Constrained= YOUNG_{it}	Constrained= BANK DEP_{it}
	GMM (1)	GMM (2)	GMM (3)	GMM (4)
$(K/L)_{i(t-1)}$	0.162***	0.136***	0.149***	-0.014
	(7.51)	(6.03)	(6.38)	(-0.83)
$Price_{it}$	-0.505***	-0.526***	-0.591***	-0.767***
	(-3.22)	(-4.01)	(-4.62)	(-7.32)
$Sales_{it}$	-0.579***	-0.685***	-0.612***	-0.872***
	(-6.23)	(-9.79)	(-9.05)	(-14.51)
$CashFlow_{it}$	-0.280***			
	(-3.37)			
$CashFlow_{it} * Constrained_{it}$		-0.212***	-0.290***	-0.339***
		(-3.45)	(-4.26)	(-4.69)
$CashFlow_{it} * (1 - Constrained_{it})$		-0.012	0.008	-0.139
		(-0.24)	(0.19)	(-1.11)
$Leverage_{it}$	-0.268**			
	(-2.18)			
$Leverage_{it} * Constrained_{it}$		-0.321**	-0.326**	-0.392
		(-2.26)	(-2.28)	(-1.56)
$Leverage_{it} * (1 - Constrained_{it})$		-0.069	0.270	-0.159
		(-0.25)	(0.82)	(-0.36)
$Collateral_{it}$	2.269***			
	(6.86)			
$Collateral_{it} * Constrained_{it}$		2.235***	2.128***	1.748***
		(5.33)	(5.19)	(3.98)
$Collateral_{it} * (1 - Constrained_{it})$		2.908***	2.691***	1.947***
		(6.71)	(5.16)	(3.99)
IB_{it}	-0.900**			
	(-2.30)			
$IB_{it} * Constrained_{it}$		-1.063***	-1.349***	-1.535***
		(-2.66)	(-2.84)	(-3.78)
$IB_{it} * (1 - Constrained_{it})$		-0.244	-0.096	-0.714***
		(-0.43)	(-0.26)	(-4.00)
F-test of equality				
$CashFlow_{it}$		0.002	0.000	0.093
$Leverage_{it}$		0.000	0.000	0.003
$Collateral_{it}$		0.079	0.298	0.514
IB_{it}		0.091	0.025	0.018
$JStatistic$	0.173	0.005	0.198	0.074
$m2$	0.820	0.571	0.579	0.308
$Instruments$	t-2; t-3; t-4	t-2; t-3; t-4	t-2; t-3; t-4	t-2; t-3; t-4

Notes: Dependent variable is log(capital/labour). All specifications were estimated using a Dynamic GMM first-differenced specification. The figures reported in parentheses are t-statistics in absolute values. * significant at 10%; ** significant at 5%; *** significant at 1%. Time dummies and time dummies interacted with industry dummies were included in all specifications. Numbers of firms and of observations are 3578 and 10223, respectively. $m2$ is a test for second-order serial correlation in the first-differenced residuals, and the J statistic is a test of the overidentifying restrictions. The F-test is a test statistic for the equality of the coefficients. Also see Notes to Tables 1 and 3.

Table 5: Robustness: an alternative capital variable

	ALL FIRM-YEARS	Constrained= $SMALL_{it}$	Constrained= $YOUNG_{it}$	Constrained= BANK DEP_{it}
	GMM (1)	GMM (2)	GMM (3)	GMM (4)
$Price_{it}$	-0.589***	-0.604***	-0.767***	-0.859***
	(-3.64)	(-5.01)	(-7.31)	(-6.58)
$Sales_{it}$	-0.687***	-0.649***	-0.760***	-0.688***
	(-7.31)	(-10.04)	(-19.57)	(-10.43)
$CashFlow_{it}$	-0.249**			
	(-2.48)			
$CashFlow_{it} * Constrained_{it}$		-0.208***	-0.213**	-0.261***
		(-2.64)	(-2.57)	(-3.03)
$CashFlow_{it} * (1 - Constrained_{it})$		0.036	0.063	-0.039
		(0.67)	(1.33)	(-0.48)
$Leverage_{it}$	-0.480***			
	(-3.13)			
$Leverage_{it} * Constrained_{it}$		-0.568**	-0.657**	-0.740***
		(-2.51)	(-2.34)	(-2.63)
$Leverage_{it} * (1 - Constrained_{it})$		-0.286	-0.444	-0.528
		(-0.75)	(-1.35)	(-1.47)
$Collateral_{it}$	1.774***			
	(3.70)			
$Collateral_{it} * Constrained_{it}$		2.370***	1.458***	1.481***
		(6.26)	(4.10)	(3.24)
$Collateral_{it} * (1 - Constrained_{it})$		2.411***	2.061***	1.737***
		(5.66)	(4.56)	(4.14)
IB_{it}	-0.694***			
	(-4.79)			
$IB_{it} * Constrained_{it}$		-1.501***	-1.489***	-0.917**
		(-3.21)	(-3.16)	(-2.17)
$IB_{it} * (1 - Constrained_{it})$		0.342	-0.139	-0.315*
		(0.62)	(-0.38)	(-1.66)
F-test of equality				
$CashFlow_{it}$		0.002	0.001	0.032
$Leverage_{it}$		0.000	0.001	0.002
$Collateral_{it}$		0.911	0.221	0.298
IB_{it}		0.005	0.014	0.092
$JStatistic$	0.117	0.491	0.201	0.486
$m2$	0.366	0.127	0.121	0.482
$Instruments$	t-2; t-3 t-4	t-2; t-3; t-4	t-2; t-3; t-4	t-2; t-3; t-4

Notes: Dependent variable is log(capital/labour). All specifications were estimated using a GMM first-differenced specification. The figures reported in parentheses are t-statistics in absolute values. * significant at 10%; ** significant at 5%; *** significant at 1%. Time dummies and time dummies interacted with industry dummies were included in all specifications. Numbers of firms and of observations are 1576 and 4572, respectively. $m2$ is a test for second-order serial correlation in the first-differenced residuals, and the J statistic is a test of the overidentifying restrictions. The F-test is a test statistic for the equality of the coefficients. Also see Notes to Tables 1 and 3.

Table 6: Robustness: alternative cut-off points

	Constrained= $SMALL_{it}$	Constrained= $YOUNG_{it}$	Constrained= $BANK\ DEP_{it}$
	GMM (1)	GMM (2)	GMM (3)
$Price_{it}$	-0.567***	-0.396***	-0.558***
	(-4.43)	(-2.86)	(-4.05)
$Sales_{it}$	-0.827***	-0.683***	-0.692***
	(-12.3)	(-10.2)	(-16.0)
$CashFlow_{it} * Constrained_{it}$	-0.211***	-0.292***	-0.354***
	(-3.11)	(-3.97)	(-4.16)
$CashFlow_{it} * (1 - Constrained_{it})$	0.061	-0.017	-0.040
	(1.62)	(-0.16)	(-0.88)
$Leverage_{it} * Constrained_{it}$	-0.299*	-0.484*	-0.566**
	(-1.88)	(-1.74)	(-2.11)
$Leverage_{it} * (1 - Constrained_{it})$	0.213	-0.114	-0.198
	(1.38)	(0.27)	(-0.57)
$Collateral_{it} * Constrained_{it}$	2.175***	3.103***	2.415***
	(5.39)	(9.10)	(5.88)
$Collateral_{it} * (1 - Constrained_{it})$	3.259***	2.850***	2.652***
	(8.76)	(7.42)	(7.29)
$IB_{it} * Constrained_{it}$	-1.531***	-1.973***	-1.117**
	(-3.89)	(-3.82)	(-2.38)
$IB_{it} * (1 - Constrained_{it})$	-0.657***	-0.515	-0.629
	(-6.07)	(-1.30)	(-1.46)
F-test of equality			
$CashFlow_{it}$	0.000	0.001	0.000
$Leverage_{it}$	0.000	0.000	0.000
$Collateral_{it}$	0.004	0.524	0.414
IB_{it}	0.021	0.007	0.352
$JStatistic$	0.06	0.083	0.127
$m2$	0.110	0.084	0.130
$Instruments$	t-2; t-3 t-4	t-2; t-3; t-4	t-2; t-3; t-4

Notes: Dependent variable is log(capital/labour). All specifications were estimated using the GMM first-differenced specification. The figures reported in parentheses are t-statistics in absolute values. * significant at 10%; ** significant at 5%; *** significant at 1%. Time dummies and time dummies interacted with industry dummies were included in all specifications. Constrained is a dummy variable that represents $SMALL_{it}$, $YOUNG_{it}$, $BANK\ DEP_{it}$. $SMALL_{it}$ is equal to 1 for firms in the bottom 50% of their real assets distribution in year *t*, and 0, otherwise. $YOUNG_{it}$ is equal to 1 for firms in the lower 50% of their age distribution in year *t*, and 0, otherwise. $BANK\ DEP_{it}$ is equal to 1 for firms in the top 50% of their mix distribution in year *t*, and 0, otherwise. Numbers of firms and of observations are 4520 and 14125, respectively. $m2$ is a test for second-order serial correlation in the first-differenced residuals, and the J statistic is a test of the overidentifying restrictions. The F-test is a test statistic for the equality of the coefficients. Also see notes to Table 1.

Table 7: Robustness: positive cash flow observations

	ALL FIRM-YEARS	Constrained= SMALL_{it}	Constrained= YOUNG_{it}	Constrained= BANK DEP_{it}
	GMM (1)	GMM (2)	GMM (3)	GMM (4)
$Price_{it}$	-0.751***	-0.630***	-0.652***	-0.731***
	(-4.67)	(-5.01)	(-5.02)	(-5.52)
$Sales_{it}$	-0.733***	-0.655***	-0.694***	-0.721***
	(-8.23)	(-9.52)	(-10.3)	(-15.4)
$CashFlow_{it}$	-0.344***			
	(-6.02)			
$CashFlow_{it} * Constrained_{it}$		-0.391***	-0.397***	-0.430***
		(-4.80)	(-5.47)	(-5.32)
$CashFlow_{it} * (1 - Constrained_{it})$		-0.124	-0.168	-0.217
		(-0.99)	(-1.55)	(-1.58)
$Leverage_{it}$	-0.497*			
	(-1.65)			
$Leverage_{it} * Constrained_{it}$		-0.489**	-0.149	-0.187
		(-2.53)	(-0.52)	(-0.72)
$Leverage_{it} * (1 - Constrained_{it})$		-0.085	-0.083	-0.797*
		(-0.23)	(-0.18)	(-1.71)
$Collateral_{it}$	1.993***			
	(4.58)			
$Collateral_{it} * Constrained_{it}$		1.844***	2.592***	2.592***
		(4.91)	(6.29)	(6.72)
$Collateral_{it} * (1 - Constrained_{it})$		2.743***	3.310***	2.135***
		(6.95)	(6.23)	(5.09)
IB_{it}	-1.055**			
	(-2.56)			
$IB_{it} * Constrained_{it}$		-0.944**	-1.753***	-0.792**
		(-2.10)	(-3.54)	(-2.07)
$IB_{it} * (1 - Constrained_{it})$		0.425	-0.001	-0.623***
		(0.75)	(-0.002)	(-3.19)
F-test of equality				
$CashFlow_{it}$		0.004	0.013	0.089
$Leverage_{it}$		0.000	0.409	0.000
$Collateral_{it}$		0.015	0.186	0.169
IB_{it}		0.036	0.003	0.621
$JStatistic$	0.064	0.311	0.04	0.006
$m2$	0.169	0.200	0.054	0.141
$Instruments$	t-2; t-3; t-4	t-2; t-3 t-4	t-2; t-3; t-4	t-2; t-3; t-4

Notes: Dependent variable is log(capital/labour). All specifications were estimated using the GMM first-differenced specification. The figures reported in parentheses are t-statistics in absolute values. * significant at 10%; ** significant at 5%; *** significant at 1%. Time dummies and time dummies interacted with industry dummies were included in all specifications. Numbers of firms and of observations are 4242 and 12260, respectively. Negative cash flow observations were excluded from our sample. $m2$ is a test for second-order serial correlation in the first-differenced residuals, and the J statistic is a test of the overidentifying restrictions. The F-test is a test statistic for the equality of the coefficients. Also see notes to Tables 1 and 3.

Table 8: Elasticities based on robustness tests

Elasticities based on results in Table 4	ALL FIRM-YEARS (1)	Constrained= SMALL$_{it}$ (2)	Constrained= YOUNG$_{it}$ (3)	Constrained= BANK DEP$_{it}$ (4)
$CashFlow_{it}$	0.072			
$Leverage_{it}$	0.047			
$Collateral_{it}$	0.669			
IB_{it}	0.046			
$CashFlow_{it} * Constrained_{it}$		0.061	0.078	0.088
$CashFlow_{it} * (1 - Constrained_{it})$		0.002	0.001	0.033
$Leverage_{it} * Constrained_{it}$		0.062	0.061	0.071
$Leverage_{it} * (1 - Constrained_{it})$		0.009	0.039	0.022
$Collateral_{it} * Constrained_{it}$		0.652	0.616	0.492
$Collateral_{it} * (1 - Constrained_{it})$		0.910	0.828	0.731
$IB_{it} * Constrained_{it}$		0.06	0.073	0.081
$IB_{it} * (1 - Constrained_{it})$		0.009	0.004	0.034

Elasticities based on results in Table 5	ALL FIRM-YEARS (1)	Constrained= SMALL$_{it}$ (2)	Constrained= YOUNG$_{it}$ (3)	Constrained= BANK DEP$_{it}$ (4)
$CashFlow_{it}$	0.064			
$Leverage_{it}$	0.084			
$Collateral_{it}$	0.523			
IB_{it}	0.036			
$CashFlow_{it} * Constrained_{it}$		0.061	0.057	0.068
$CashFlow_{it} * (1 - Constrained_{it})$		0.007	0.014	0.009
$Leverage_{it} * Constrained_{it}$		0.108	0.123	0.134
$Leverage_{it} * (1 - Constrained_{it})$		0.037	0.064	0.073
$Collateral_{it} * Constrained_{it}$		0.692	0.422	0.417
$Collateral_{it} * (1 - Constrained_{it})$		0.754	0.634	0.653
$IB_{it} * Constrained_{it}$		0.085	0.08	0.048
$IB_{it} * (1 - Constrained_{it})$		0.013	0.006	0.015

Elasticities based on results in Table 6	Constrained= SMALL$_{it}$ (1)	Constrained= YOUNG$_{it}$ (2)	Constrained= BANK DEP$_{it}$ (3)
$CashFlow_{it} * Constrained_{it}$	0.064	0.081	0.094
$CashFlow_{it} * (1 - Constrained_{it})$	0.013	0.003	0.009
$Leverage_{it} * Constrained_{it}$	0.064	0.095	0.106
$Leverage_{it} * (1 - Constrained_{it})$	0.029	0.018	0.028
$Collateral_{it} * Constrained_{it}$	0.610	0.881	0.639
$Collateral_{it} * (1 - Constrained_{it})$	1.003	0.866	0.998
$IB_{it} * Constrained_{it}$	0.094	0.106	0.06
$IB_{it} * (1 - Constrained_{it})$	0.028	0.026	0.03

Elasticities based on results in Table 7	ALL FIRM-YEARS (1)	Constrained= SMALL$_{it}$ (2)	Constrained= YOUNG$_{it}$ (3)	Constrained= BANK DEP$_{it}$ (4)
$CashFlow_{it}$	0.108			
$Leverage_{it}$	0.088			
$Collateral_{it}$	0.587			
IB_{it}	0.054			
$CashFlow_{it} * Constrained_{it}$		0.129	0.131	0.136
$CashFlow_{it} * (1 - Constrained_{it})$		0.033	0.046	0.065
$Leverage_{it} * Constrained_{it}$		0.093	0.028	0.034
$Leverage_{it} * (1 - Constrained_{it})$		0.011	0.012	0.110
$Collateral_{it} * Constrained_{it}$		0.538	0.751	0.730
$Collateral_{it} * (1 - Constrained_{it})$		0.858	1.019	0.802
$IB_{it} * Constrained_{it}$		0.053	0.094	0.041
$IB_{it} * (1 - Constrained_{it})$		0.016	0.000	0.029

Notes: Elasticities were calculated using the following form: $d(lny)/d(x)$=β*$mean(x)$. The coefficients on cash flow, leverage, collateral, interest burden and the interacted terms were multiplied with their means to extract the elasticities. Also see notes to Tables 1 and 3.

Figure 1: K/L for small and large firms

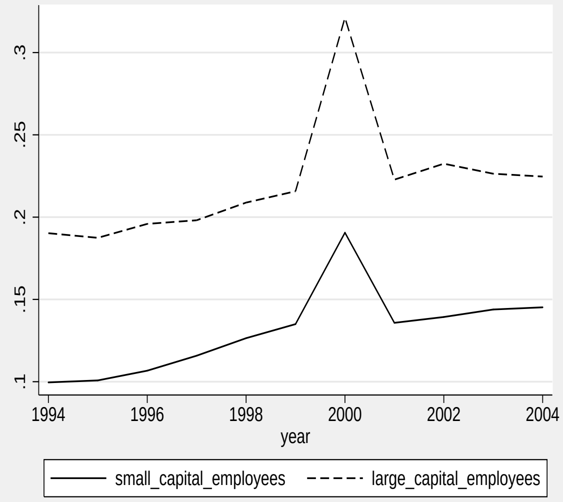


Figure 2: percentage change in the number of employees

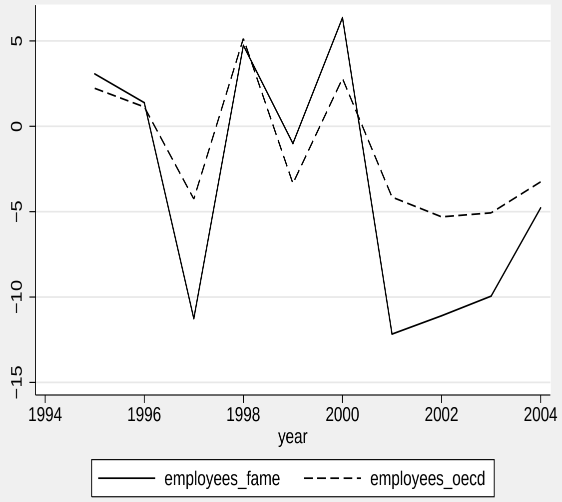


Figure 3: percentage change in investment

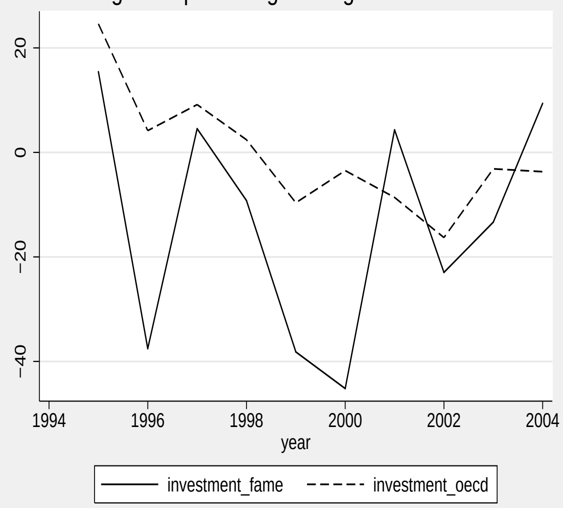


Figure 4: average number of employees

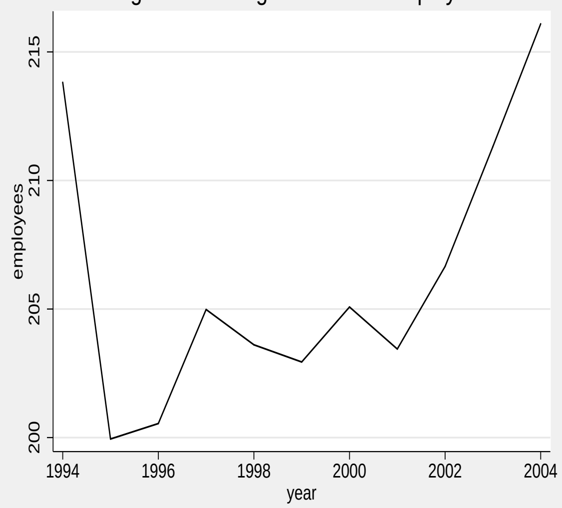


Figure 5: average capital stock

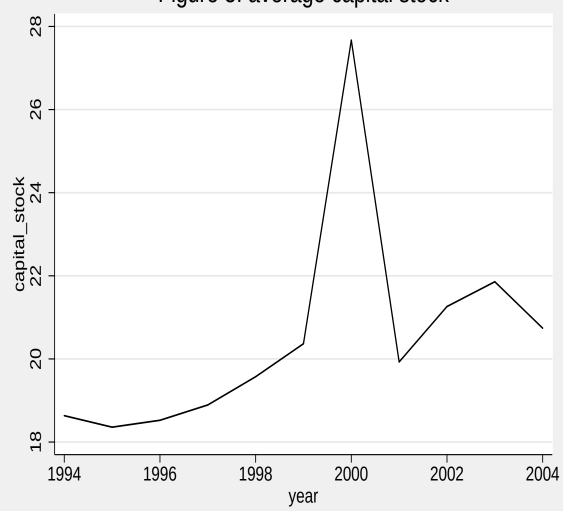
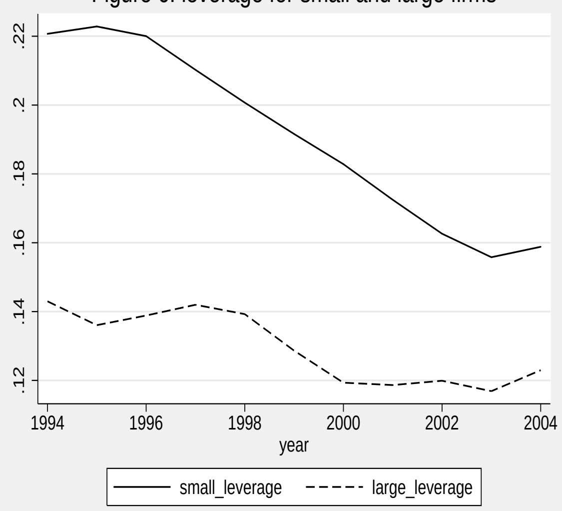


Figure 6: leverage for small and large firms



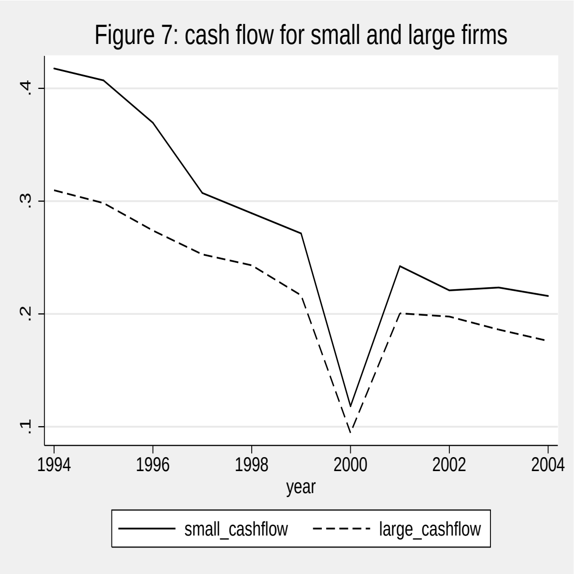


Figure 7: cash flow for small and large firms
.1
.2
.3
.4
1994
1996
1998
2000
2002
2004
year
small_cashflow
large_cashflow

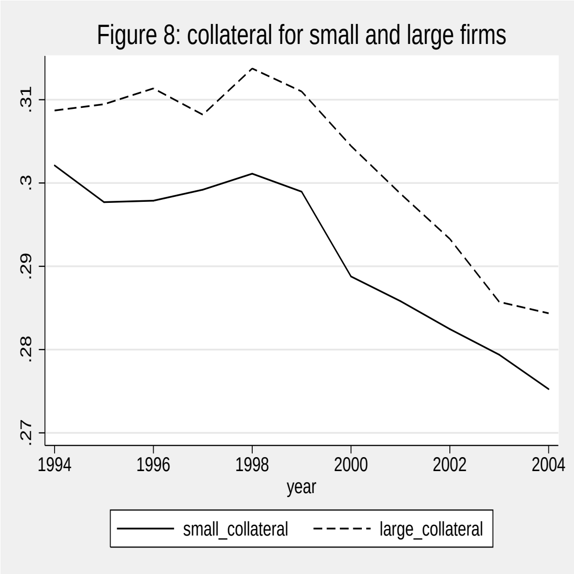


Figure 8: collateral for small and large firms
.27
.28
.29
.3
.31
1994
1996
1998
2000
2002
2004
year
small_collateral
large_collateral

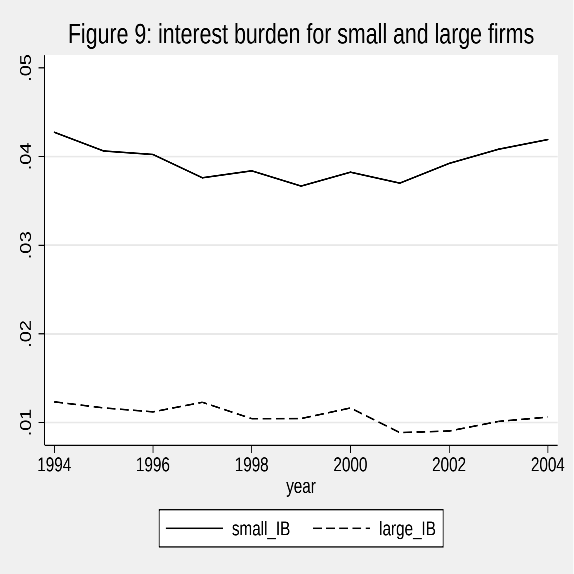


Figure 9: interest burden for small and large firms
.01
.02
.03
.04
.05
1994
1996
1998
2000
2002
2004
year
small_IB
large_IB

Working Paper List 2008

Number	Author	Title
08/10	Marta Aloi, Manuel Leite-Monteiro and Teresa Lloyd-Braga	Unionized Labor Markets and Globalized Capital Markets
08/09	Simona Mateut, Spiros Bougheas and Paul Mizen	Corporate trade credit and inventories: New evidence of a tradeoff from accounts payable and receivable
08/08	Christos Koulovatianos, Leonard J. Mirman and Marc Santugini	Optimal Growth and Uncertainty: Learning
08/07	Christos Koulovatianos, Carsten Schröder and Ulrich Schmidt	Nonmarket Household Time and the Cost of Children
08/06	Christiane Baumeister, Eveline Durinck and Gert Peersman	Liquidity, Inflation and Asset Prices in a Time-Varying Framework for the Euro Area
08/05	Sophia Mueller-Spahn	The Pass Through From Market Interest Rates to Retail Bank Rates in Germany
08/04	Maria Garcia-Vega and Alessandra Guariglia	Volatility, Financial Constraints and Trade
08/03	Richard Disney and John Gathergood	Housing Wealth, Liquidity Constraints and Self-Employment
08/02	Paul Mizen and Serafeim Tsoukas	What Effect has Bond Market Development in Asia had on the Issue of Corporate Bonds
08/01	Paul Mizen and Serafeim Tsoukas	Modelling the Persistence of Credit Ratings When Firms Face Financial Constraints, Recessions and Credit Crunches

Working Paper List 2007

Number	Author	Title
07/11	Rob Carpenter and Alessandra Guariglia	Investment Behaviour, Observable Expectations, and Internal Funds: a comments on Cummins et al, AER (2006)
07/10	John Tsoukalas	The Cyclical Dynamics of Investment: The Role of Financing and Irreversibility Constraints
07/09	Spiros Bougheas, Paul Mizen and Cihan Yalcin	An Open Economy Model of the Credit Channel Applied to Four Asian Economies
07/08	Paul Mizen & Kevin Lee	Household Credit and Probability Forecasts of Financial Distress in the United Kingdom
07/07	Tae-Hwan Kim, Paul Mizen & Alan Thanaset	Predicting Directional Changes in Interest Rates: Gains from Using Information from Monetary Indicators
07/06	Tae-Hwan Kim, and Paul Mizen	Estimating Monetary Reaction Functions at Near Zero Interest Rates: An Example Using Japanese Data
07/05	Paul Mizen, Tae-Hwan Kim and Alan Thanaset	Evaluating the Taylor Principle Over the Distribution of the Interest Rate: Evidence from the US, UK & Japan
07/04	Tae-Hwan Kim, Paul Mizen and Alan Thanaset	Forecasting Changes in UK Interest rates
07/03	Alessandra Guariglia	Internal Financial Constraints, External Financial Constraints, and Investment Choice: Evidence From a Panel of UK Firms
07/02	Richard Disney	Household Saving Rates and the Design of Public Pension Programmes: Cross-Country Evidence
07/01	Richard Disney, Carl Emmerson and Matthew Wakefield	Public Provision and Retirement Saving: Lessons from the U.K.

Working Paper List 2006

Number	Author	Title
06/04	Paul Mizen & Serafeim Tsoukas	Evidence on the External Finance Premium from the US and Emerging Asian Corporate Bond Markets
06/03	Woojin Chung, Richard Disney, Carl Emmerson & Matthew Wakefield	Public Policy and Retirement Saving Incentives in the U.K.
06/02	Sarah Bridges & Richard Disney	Debt and Depression
06/01	Sarah Bridges, Richard Disney & John Gathergood	Housing Wealth and Household Indebtedness: Is There a 'Household Financial Accelerator'?

Working Paper List 2005

Number	Author	Title
05/02	Simona Mateut and Alessandra Guariglia	Credit channel, trade credit channel, and inventory investment: evidence from a panel of UK firms
05/01	Simona Mateut, Spiros Bougheas and Paul Mizen	Trade Credit, Bank Lending and Monetary Policy Transmission