SOME EVIDENCE ON FINANCIAL FACTORS IN THE DETERMINATION OF AGGREGATE BUSINESS INVESTMENT FOR THE G7 COUNTRIES

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Abstract: Standard theories of investment behaviour have concentrated on the neoclassical and Tobin's Q approaches, with most empirical work on aggregate data focusing on the former. In contrast, a separate literature on monetary transmission, centred on the credit channel and financial accelerator effects, has highlighted the potential impact of credit market imperfections in constraining the investment behaviour of firms. In this paper we present evidence at a macro level for the G7 countries that a broad range of financial variables, consistent with the valuation ratio, financial accelerator and credit channel approaches, are relevant determinants of business fixed investment above those variables normally included in traditional macroeconomic investment functions. The results indicate a wider incidence of these financial effects on investment than the existing literature, focused as it is on the US, would otherwise indicate.

Keywords: Investment, corporate finance, financial accelerator, credit channel.

JEL Classification: E22, E44, G31

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1. Introduction.

The evident importance of fixed investment both to the cyclical and to the long-term structural development of the economy has given it a central place in theoretical macroeconomics and in the analysis of economic growth. Such analysis has a particular topicality today, where falls in investment following previous periods of "overinvestment" have been an observed feature of recent sharp and persistent downturns in economies such as Japan and the East Asian countries. There is also some debate on this issue in the US. However, the specification of investment functions in empirical work has tended to be rather unsophisticated. The models tend to draw from either or both of the neo-classical model, determined largely by the distributed lag of income and the user cost of capital, and the capital stock adjustment model, featuring the capital stock and the long term interest rate.

Although the "Tobin's Q" approach to investment, based on the valuation ratio of equity to capital, has proved popular in theoretical circles (Caballero 1999), its use in empirical research is less common[2]. Moreover, recent years have witnessed the development of the financial accelerator approach to investment (Bernanke et al 1999), which focuses on the possible rationing of external finance when firms' net worth declines, owing to the incidence of adverse selection and moral hazard for providers of external finance. Complementing this, discussion of the credit channel emphasises the importance of bank credit as a key source of external finance, notably for small firms for which the problem of asymmetric information is important. Research on these matters using macro data also remains limited, and in particular, work has tended to focus on a single country level.

In this context, we seek to assess the effects of aggregate financial effects on investment in an augmented accelerator model for the G7 major industrial economies. In doing so we seek to provide insight into real-financial interactions in this important area of the macroeconomy, and thereby contribute to a better understanding of the monetary transmission process and movements in the business cycle more generally. Some insights are also gathered into how investment performance varies as economies undergo structural changes to their financial sectors. We show in particular that financial variables arising from Tobin's Q, the financial accelerator and the credit channel are often key determinants of aggregate business investment across the G-7 countries.

[2] For examples of Q incorporated in macroeconometric models, see Christodoualakis and Weale (1987) and Davis (1987)

2. Recent developments in investment and patterns of corporate financing.

A number of recent macroeconomic and structural developments have given rise to enhanced interest in the determinants of fixed investment and its link to financial conditions, namely:

- Financial liberalisation, while entailing a less important change in financing conditions for the corporate rather than the personal sector, may have increased availability of loan finance for business investment under normal conditions, and hence raised the equilibrium level of gearing.
- The development of securities markets, which has offered an alternative source of debt finance for companies to complement bank credit. This is widely seen as allowing enhanced smoothing of corporate expenditures, owing to the diversification benefits of such "multiple avenues of intermediation" (Davis 2001).
- The increased incidence of financial instability, which in abnormal conditions may lead to a cut-off in the availability of financing to the corporate sector and subsequently sharp falls in investment. This was apparent in a number of countries during the downturn in the business cycle of the late 1980s and early 1990s, see Davis (1995)).
- The boom in equity prices in recent years, and potential links to corporate investment (e.g. via the valuation ratio between equity values and the capital stock.)
- The potential for over-investment and the development of unprofitable overhangs in the capital stock, with recessionary consequences, notably in East Asia and Japan.
- The structural differences between financial systems (in particular, relationship banking versus transactions banking,) which, it is often argued, appear to be breaking down, with a convergence towards the Anglo-Saxon transactions based model. This would entail a loss of some intertemporal risk sharing benefits available from relationship banking that could help to smooth corporate investment expenditures (Allen and Gale 1995, 1997).
- Development of institutional investors, which may increase availability of bond and equity finance to companies to finance investment, while also enhancing oversight of corporate managers by way of corporate governance mechanisms (Davis and Steil 2001).

Our work in this paper relies on a combination of macroeconomic data obtained from national data sources, the OECD business sector database, and from national flow of funds balance sheets. Charts for some of the main variables of interest are appended; a data appendix provides details of the series used.

Chart 1 shows the corporate debt/equity ratio, which as we discuss below is a key indicator of the financial accelerator effect. A consistently higher level is maintained in Germany and Japan than elsewhere, in line with "relationship banking" enhancing availability of debt and

Chart 1A: G-7 corporate debt-equity ratios

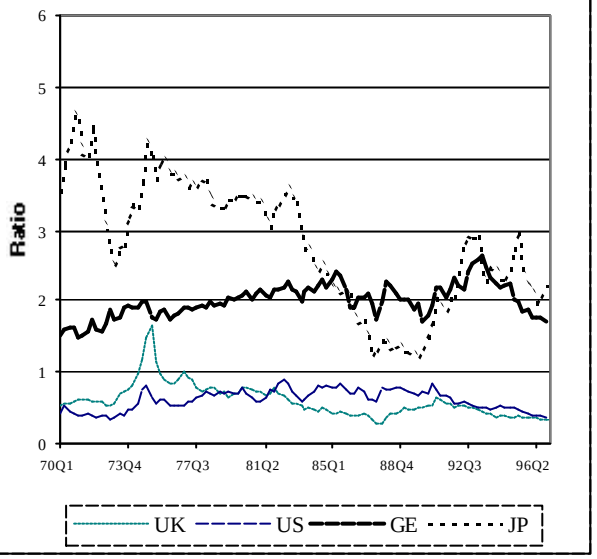


Chart 1B: G-7 corporate debt-equity ratios

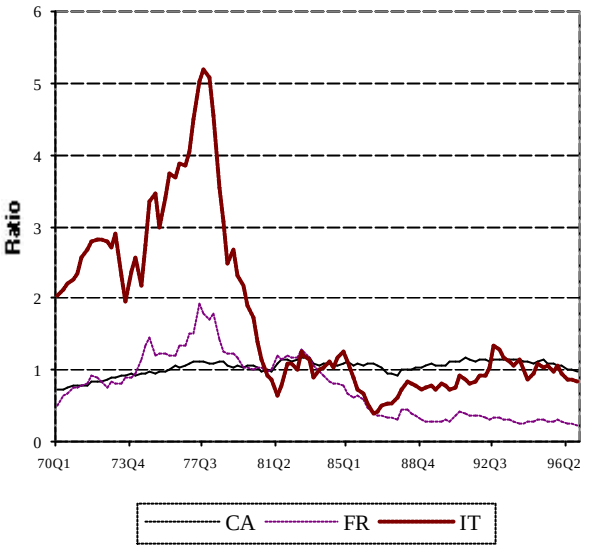


Chart 2A: Tobin's Q ratio

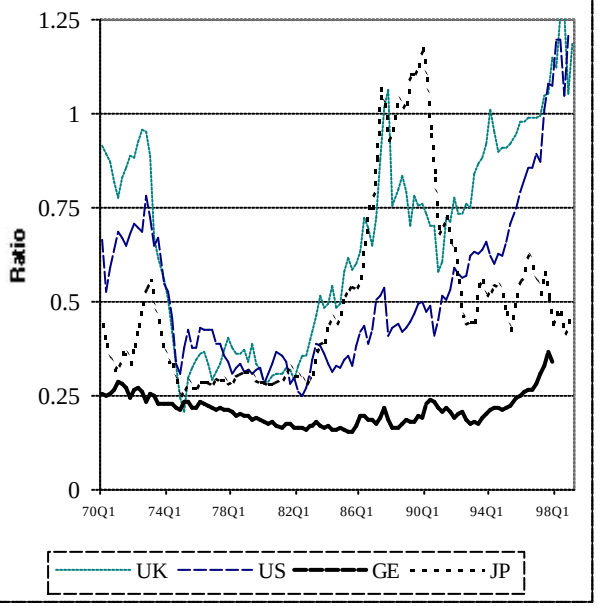
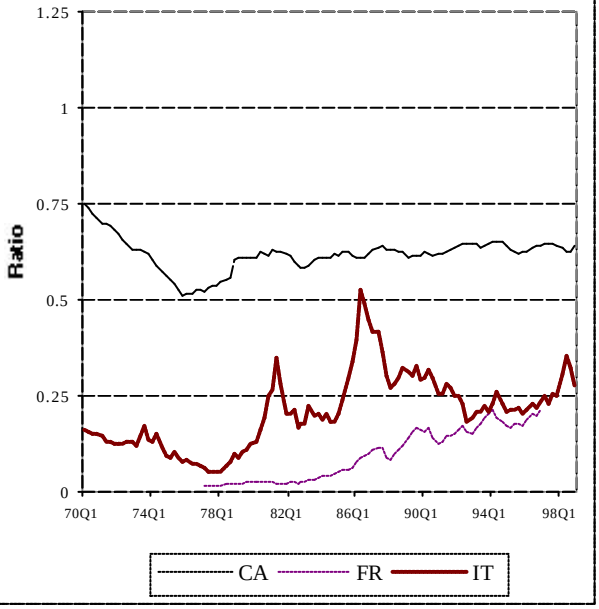


Chart 2B: Tobin's Q ratio



less developed equity markets. At an earlier stage, Italian data shows high volatility, but the country is now in line with Canada at a ratio of around 1.0. Finally, the UK, US and France all have a low ratio of about 0.5. Note that for France the measure of equity includes a high level of imputed equity of non-corporate business, which may bias the ratio downwards compared to other countries. For most countries, the ratio follows a cyclical pattern, with higher levels being apparent in recessions.

Data for Tobin's Q, measured as the corporate sector stock of equity outstanding divided by the corporate capital stock, are shown in Chart 2. (Data sources and definitions are provided in the Data Appendix.) Consistent with the debt-equity ratio, somewhat different average levels are maintained in the G-7 countries. Average ratios in France, Germany and Italy are below 0.5, while in the US, UK, Canada and Japan they are around 1.0. The time series for most countries shows low levels in the 1970s and relatively high levels in the 1960s (where data are available) and 1990s. This is consistent inter alia with trends in the profit share of GDP, as well as improved economic growth prospects. The highest levels in the late 1990s are in the UK and the US, with Q ratios of well in excess of one, similar to those found in Japan in the late 1980s, which later proved unsustainable in the longer run.

Chart 3 shows the ratio of corporate debt to GDP, which is often employed as a proxy for measuring the "financial fragility" of the corporate sector (Davis 1995). Japan displays a much higher level of leverage (over 100%) than the other countries shown, according to this measure. Other countries are bunched in the range 25-75%, with the US and UK at around 25-40% and the others in excess of 50%. There is an upward trend apparent in the 1980s, which was reversed after the recession of the early 1990s in most countries (when "financial fragility" was often severe). However, ratios prior to 1973 were often comparable with the highest levels observed since the 1970s.

Bank debt to total debt ratios, as we discuss below, give a measure of the credit channel, as they indicate the relative dominance of bank lending as a source of corporate finance in the various countries, and also whether bank finance becomes more important relative to capital markets in recessions. Chart 4 shows that bond finance is relatively unimportant outside the "Anglo Saxon" countries, although a rise in securities finance is apparent in France and Japan in the early 1990s. The share of bank financing has been volatile in the UK, with a ratio of 45% as in the US and Canada prior to 1973, after which securities financing underwent a sharp decline (see Davis 1992.) There is tentative evidence of bank financing being higher in recessions (in 1973, 1982 and 1991) although this may be overlaid by the effects of financial liberalisation on bank lending (e.g. in the 1980s.)

Chart 3A: Debt/GDP ratios

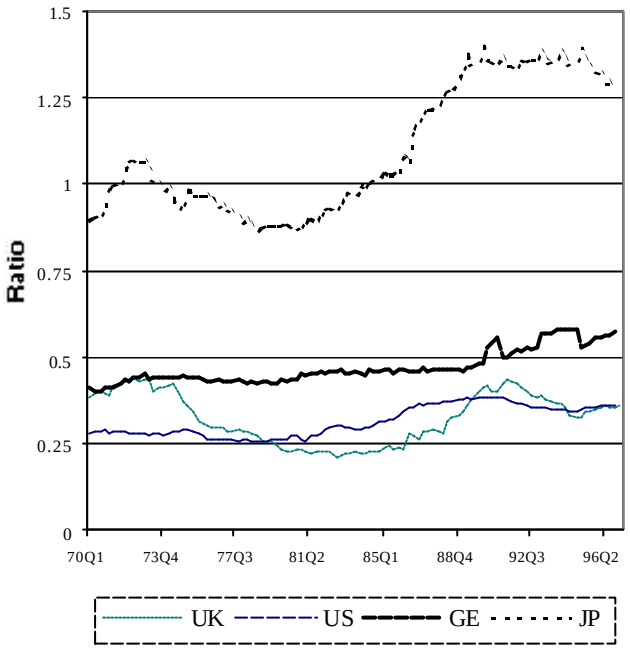


Chart 3B: Debt/GDP ratios

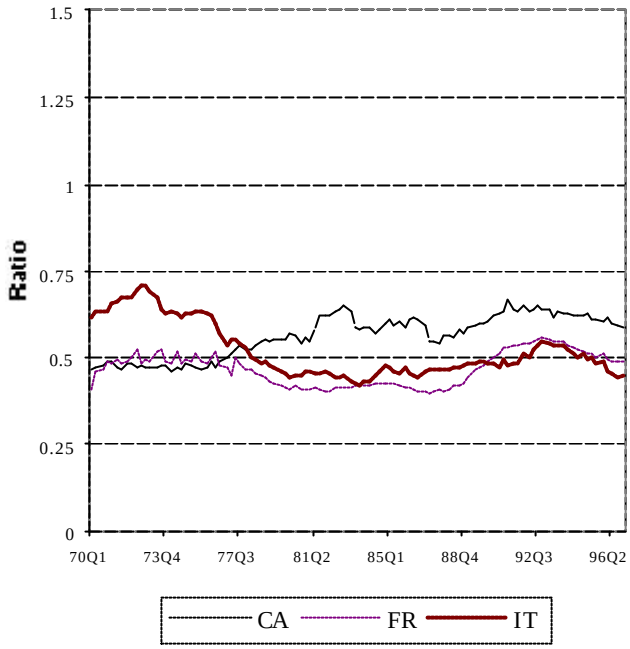


Chart 4A: Bank loans/Debt ratios

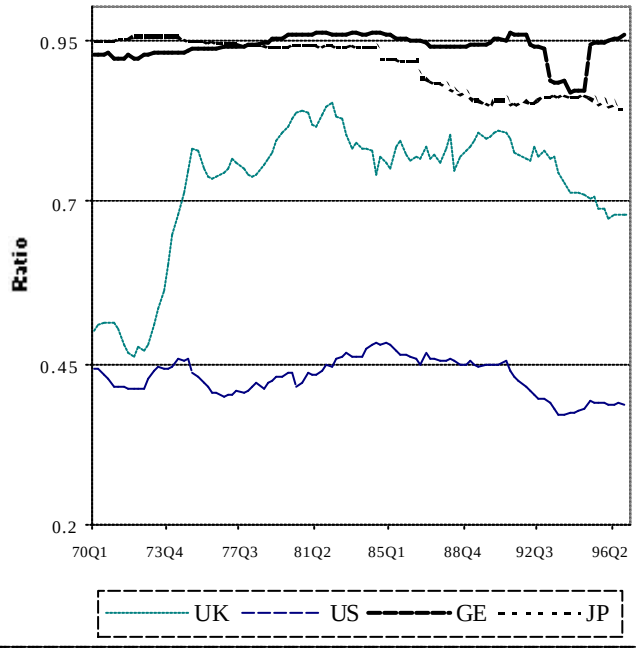


Chart 4B: Bank loans/Debt ratios

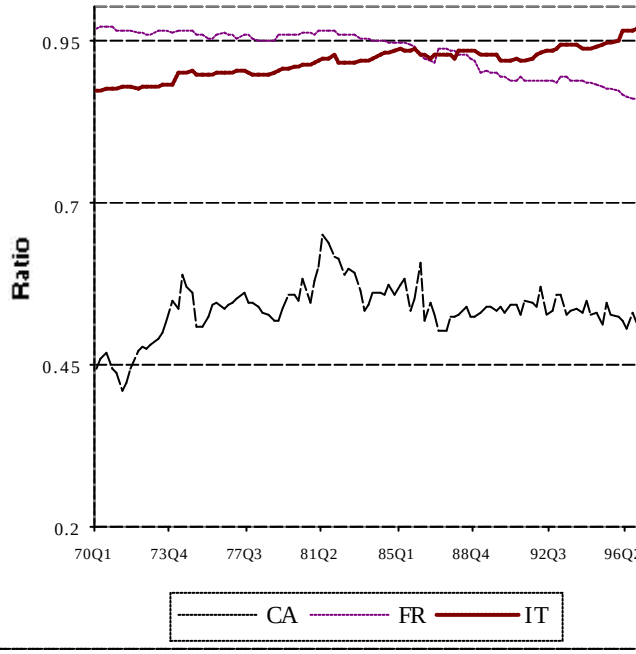


Chart 5A: Investment/GDP ratios

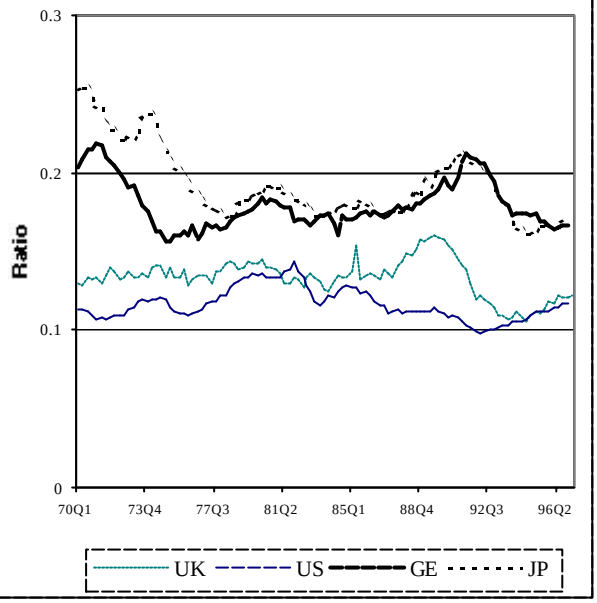
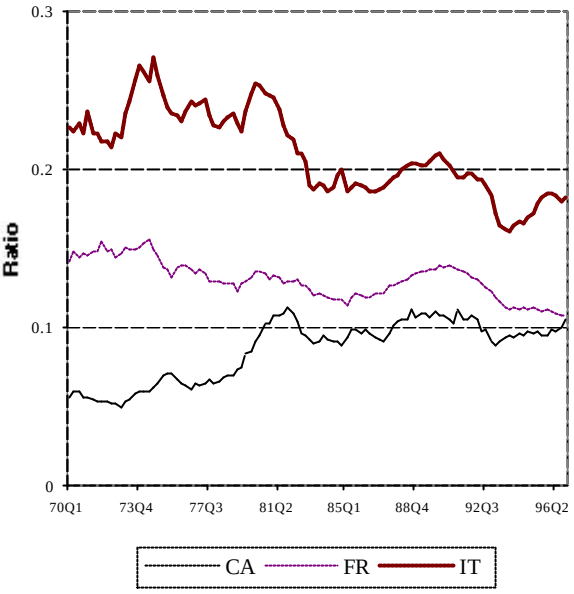


Chart 5B: Investment/GDP ratios



Charts 5 to 7 complement these financial ratios by showing the real economic variables that are the subject of this study. Chart 5 shows the ratio of business sector investment to GDP, which in the 1980s and 1990s has been in the range of 10-20% for all countries. Higher ratios were observed in Japan, Germany and Italy in the early 1970s, and lower ratios in Canada. For most countries, this ratio appears to be cyclical. Chart 6 shows the ratio of business sector investment to the capital stock, measured on a similar basis. Ratios for France, Germany and Italy are relatively low and strongly correlated, whereas the Anglo-Saxon countries and Japan show somewhat higher ratios. Of course, the ratio is affected by assumed depreciation and scrapping rates for capital and not only by investment per se. Finally, Chart 7 shows the ratio of the business sector capital stock to GDP. There is a distinction here between the US and Canada, which have relatively low levels of this ratio at about 100-150%, and the European countries and Japan, which exhibit much higher levels of between 200-250%.

Chart 6A: Investment/Capital ratios

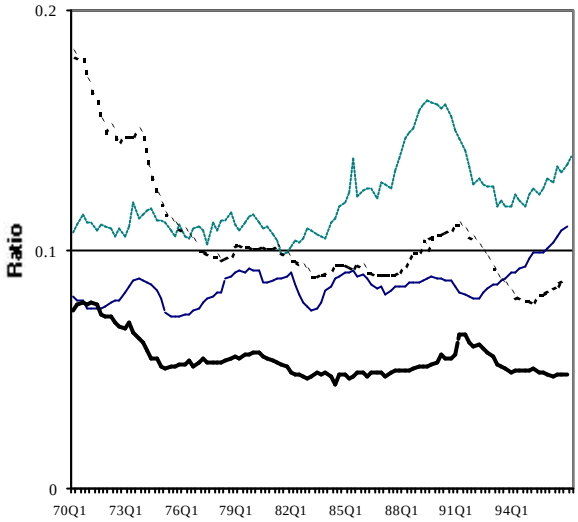


Chart 6B: Investment/Capital ratios

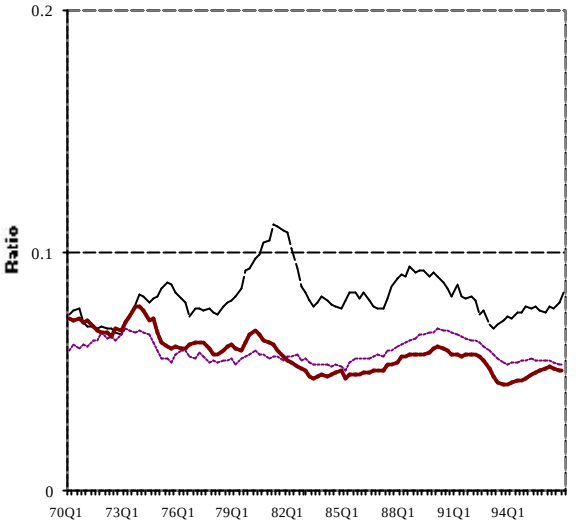


Chart 7A: Capital/GDP ratios

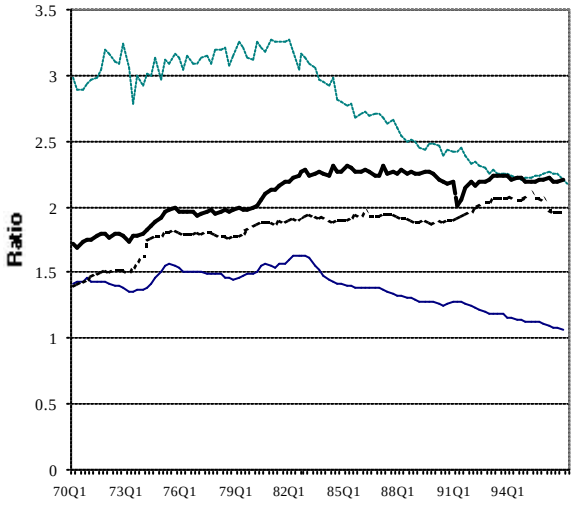
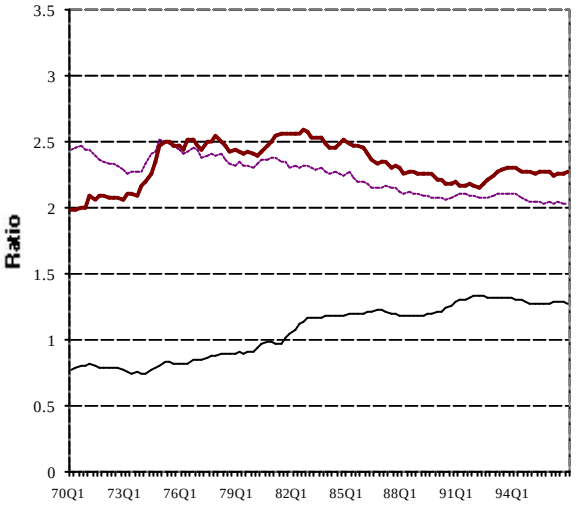


Chart 7B: Capital/GDP ratios



3. Literature survey on investment and the financing of investment.

3.1 Investment functions.

Modern theories of aggregate investment behaviour in the literature and resultant empirical work have developed from the neo-classical model first proposed by Jorgensen (1963) and the Tobin's Q model originally due to Tobin (1969) and Tobin and Brainard (1968). The neo-classical model is itself an extension of the simple accelerator models, but augmented to include the effects of relative price variables, specifically the user cost of capital. This is computed from the purchase cost of the additional capital, the rates of interest and depreciation and the levels of relevant taxes. Alternatively, the q-theory of investment argues that the level of investment is determined by the average q statistic, defined as the financial value of the firm relative to the replacement cost of the unit of capital[3].

In the neo-classical model the firm maximises the discounted flow of all future profits, with adjustment costs assumed to be absent. If we assume that the production function is characterised by a constant elasticity of substitution between capital and other inputs, then we can obtain the following familiar relationship between the desired capital stock, the level of output and the user cost of capital, from the static first order conditions of the firm's maximisation problem

$$K^* = \frac{aY}{C_k^s} \tag{1}$$

where K^* is the desired level of the capital stock, Y is the level of output, C_k is the user cost of capital (otherwise referred to as the rental cost), a is a function of capital and labour and other factors, and s is the elasticity of substitution parameter between inputs in the production function. The user cost of capital is usually defined as

$$C_k = P_k (r + d)\frac{(1 - tdep - tcred)}{(1 - t)} \tag{2}$$

where P_k is the purchase price of a unit of capital, r is the real post-tax financial cost of capital, d is the depreciation rate of capital (assumed to be geometric), *tcred* is the rate of

[3] Both Chirinko (1993) and Caballero (1999) provide excellent surveys of modern developments in the

investment tax credit, *tdep* is the discounted rate of depreciation tax allowances and t is the rate of corporation tax.

By assuming either that net investment is determined as a distributed lag process of changes in the desired capital stock, or that there are explicit costs of adjustment, it is possible to obtain an investment function for empirical estimation that equates the level of investment to the capital stock in the previous period, lags of the change in the level of output and the user cost of capital.

An alternative formulation of aggregate investment behaviour by Tobin (1969) and Brainard and Tobin (1968) argues that investment should be an increasing function of the ratio of the capitalised financial value of the firm relative to the replacement (purchase) cost of the unit of capital. This ratio is known as Tobin's Q or *average Q*. We can write the investment equation most simply as

$$I = bQ \tag{3}$$

where b is a strictly positive parameter. If q is greater than one then the investment should be undertaken and the capital stock increased, whereas for values of Q less than one further investment should not be undertaken and the capital stock should in fact be reduced. Abel (1980), Hayashi (1982) and Lucas and Prescott (1971) have shown that if Tobin's Q is included in the firms optimisation problem with adjustment costs, then investment is dependent on the level of *marginal Q*. *Marginal Q* is the ratio of the future marginal returns on investment, relative to the current marginal costs of investment. Values of Q above one will provide a stimulus to investment. Marginal Q is unobservable; however Hayashi demonstrated that when the production and adjustment cost functions adhere to certain homogeneity conditions (implying inter alia that there is no market power) then marginal and average Q are equal. So in practice empirical researchers have included measures of average q in their investment equations[4]. Unfortunately the Q model's empirical performance has been generally unsatisfactory and there are additional difficulties in using Q to forecast, centred on the need to project equity prices forward.[5]

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investment literature.

[4] See Cuthbertson and Gasparro (1995) for empirical results on the significance of Tobin's Q in investment decisions in UK manufacturing and Sensenbrenner (1991) for evidence from 6 OECD countries.

[5] For recent work on q see Cooper and Ejarque (2001)

Two recent developments in the literature suggest that aspects of the financing of investment by firms through borrowing could yield some additional information regarding the determinants of the level of business investment, namely the financial accelerator and the credit channel effect. Whereas both of these concepts rely on the effects of asymmetric information on credit rationing of external finance, the former applies to all debt financing, while the latter focuses more closely on the special nature of bank lending. These extensions will be examined in the following sections, and addressed further in our empirical work below.

3.2 The financial accelerator.

Concerning the demand for credit by firms, both macroeconomic and finance theory suggest that fixed investment and other financing vary cyclically, while interest rates also affect the demand for credit. As regards the sources of funds, the traditional "pecking order" view of corporate finance (see Myers 1984) suggests that external debt finance, either in the form of securities or lending, ranks highly for borrowing firms as a source of funds. Internal funds are cheaper, but are generally limited by the scale of expenditures (including dividends) that tend increasingly to outstrip such internal funds during a cyclical upturn, whereas cash-flows shrink in a downturn. Although in principle equity issuance is also a feasible alternative, firms tend to view it as costly and less desirable than debt, while investors often view equity issuance as an adverse signal about the firm. A further alternative, the run-down of liquidity, is limited by the need for maintaining precautionary levels of such liquidity to avoid liquidity crises. The size and structure of the balance sheet also limit collateral.

The supply of external debt finance, be it intermediated or not, is nevertheless problematic, as a consequence of asymmetric information between borrowers and lenders and the inability of lenders to write complete contracts covering borrowers' behaviour in every eventuality. These give rise to the well-known agency problems of the debt contract, linked to adverse selection in advance of lending and moral hazard after the financing has taken place. These effects may vary over time, giving rise to cyclical changes in credit supply in equilibrium (as suggested by Holmstrom and Tirole (1997) and Repullo and Suarez (2000)).

In more detail, Mishkin (1991) suggests that variations in agency costs affecting credit supply may occur via a number of channels, prompting potentially sharp changes in the availability of corporate finance across the business cycle. For example, if interest rates rise due to monetary tightening or merely to balance the credit market, adverse selection may increase sharply, giving rise to a substantial decline in credit availability. Collateral is a means

whereby asymmetric information problems may be reduced, but implies that a decrease in the valuation of assets (e.g. a stock market decline provoked by a change in future profit expectations), by lowering collateral values, sharply increases adverse selection for lenders. Reductions in credit supply will impinge more on low-quality borrowers for whom there is asymmetric information. A parallel mechanism operates via the link of net worth to moral hazard. The agency problem is greater when borrowers have low net worth as they have less to lose from default.

Such movements are said to give rise to a "financial accelerator" or "broad credit channel" effect (Bernanke, Gertler and Gilchrist 1996 and 1999.) Changes in cash flow or asset prices over the cycle give rise to pro-cyclical feedback effects of agency costs on the cost of external finance (both from banks and securities markets) and hence on real corporate expenditures. This will operate, in particular, via borrowers whose net worth is most heavily affected during a recession, and via borrowers whose activities are riskier or harder to monitor. Small firms are examples in each case. Small firms may be seen as offering higher credit risk, without regard to the state of the business cycle, since it is more difficult for potential lenders to assess the risk of default by small firms due to the problems of asymmetric information. The owner of a small firm has in general much better information on his firm's performance than the lender and more control of the outcome. In contrast, the performance of larger firms will be reflected in their corporate bond spread and share price listed on equity markets, and the state of the firm's balance sheet will be under continual scrutiny by investment analysts in the market.

Looking in more detail at the operation of the financial accelerator over the cycle, during an expansion when monetary policy is relaxed, all firms can initially finance themselves with retained earnings while balance sheets are strong. In these periods the demand for external finance is likely to be low. Demand for external finance picks up late in the cycle as investment demand outstrips retentions. In a downturn, revenue typically falls faster than expenditure, leading firms to redouble their demand for external finance, but from different sources. Smaller firms are more likely to be solely reliant for their external finance on banks, which normally require that assets be provided as collateral for loans[6] and charge high spreads. Larger firms should find it easier to borrow through the corporate bond markets or

[6] See Lund and Wright (1999) for an investigation into the sources of external funds for small firms in the UK. Although the proportion of external finance for small and medium size enterprises (SME's) has fallen slightly it still makes up almost 50 per cent of total external finance to SME's. According to data published in the Bank of England's Quarterly Report on Small Business Statistics for January 2000 Banks provided 60 per cent of the external finance for SME's between 1987-90 and 48 per cent of the external finance between 1995-97 (See Annex.)

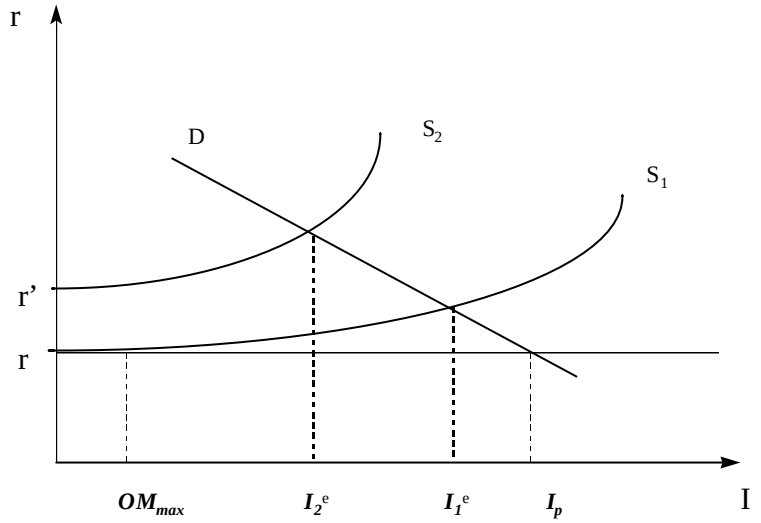
use their credit standing to obtain unsecured lending at lower spreads than those available from banks[7]. The recession itself reduces asset values and net worth, thus raising the incidence of credit rationing (both by price and quantity) for all firms, as well as increasing the incidence of monitoring[8] (Holmstrom and Tirole 1997). An increase in interest rates for monetary policy purposes, if it triggers or accompanies the recession, will accentuate credit rationing. This may make it harder for firms to secure future borrowing at any price and leads to an increase in bankruptcies and business failures.

The credit-based explanation of asymmetry is set out in Figure 3, which illustrates the financial accelerator effect. D is the firm's demand for investment funds and S_1 is the initial supply curve. Up to OM_{max} we assume that the firm can either attract sufficient funds at the open market rate of interest or through internal funding. For investment funds greater than OM_{max} the firm needs to attract external finance and will incur a risk premium on the interest rate it pays on those funds. That risk premium and the overall interest rate will increase with the quantity of investment funds required because the risk of default on the loan is increasing. In equilibrium, investment is equal to I_1^e, which is below the level that would be achieved in a perfect capital market where the firm can borrow limitlessly at the market interest rate I_p. A contraction in monetary policy which raises the market interest rate to r', shifts the supply curve to S_2. S_2 is steeper than the initial supply curve S_1 because at higher interest rates the borrower's probability of default is even higher and is reflected in a higher risk premium and consequently a higher interest rate.

[7] See Saidenberg and Strahan (1999) for a recent look at the importance of banks as a source of funds for large businesses in the US. Fisher (1999) developed a general equilibrium model of the bank-lending channel of monetary transmission with imperfect credit markets to show that the effects of shifts in monetary policy on the borrowing of small firms is greater than the effects on large firms. In the model small firms are assumed to depend on banks for external finance. The interest rate for this finance reflects the costs to the bank of verifying the private information known by these firms about their revenues. In contrast, large firms have access to public debt markets to raise external finance. Gertler and Gilchrist (1994) demonstrated that small firms in the US manufacturing sector suffered a greater fall in output than larger firms in response to contractionary monetary policy.

[8] If monitoring reduces the private benefit an enterpreneur gets from investment, this may reduce investment independently of credit rationing per se.

Figure One: The Financial Accelerator.



Important empirical tests of the hypothesis for the US include Bernanke et al (1996), who show that after a monetary tightening, the relationship between internal funds and investment becomes stronger for smaller firms than larger firms. Additionally, small firms experience much more pro-cyclical variation in economic activity than do large firms. Oliner and Rudebusch (1996) found similar results. Hu (1999) using individual firm data showed that monetary contractions reduce investment more for highly leveraged firms than for less leveraged ones. Using flow of funds data, Christiano et al (1996) showed that following a monetary policy shock, borrowing of large corporate firms rises for some time, before falling off in the subsequent recession (perhaps because cash flows fall before expenditures can be adjusted). In contrast, the borrowing of small non-corporate firms (whose net worth may be hit by the monetary policy action) is much weaker.

Less work has been done on studying the impacts of these effects in countries other than the US. Vermuelen (2001) has applied the approach to Germany, France, Italy and Spain using micro data and shows that weak balance sheets are more important in explaining investment during downturns than strong balance sheets during upturns, while effects of the accelerator are greatest for small firms. Looking at the UK, Guariglia (1999) finds a significant link from financial variables to inventory investment, which is stronger for firms with weak balance sheets, during periods of recession and when there is tight monetary policy.

3.3 The credit channel.

Whereas the accelerator focuses on total external finance, the credit channel focuses more directly on the special nature of bank lending, and suggests that after a monetary tightening,

bank lending falls relatively more than other types of debt, thus having a separate effect on the wider economy. As noted by Bernanke (1993), the basic assumptions needed for bank credit to have a separate effect on the economy from money are; first, that banks do not consider loans perfect substitutes for securities in their portfolios[9] and, second, that loans and bond issues are not perfect substitutes for all companies due to capital market imperfections. In Bernanke and Blinder (1988), a draining of reserves induced by central-bank open market policy leads, on the assumption that reserve requirements bind on banks, to a reduction in money (bank liabilities) and a parallel contraction in bank assets, as well as a rise in interest rates. If loans and securities are not perfect substitutes among bank assets, and assuming initial portfolio balance, both will tend to be reduced when the balance sheet contracts, so as to maintain portfolio balance, with banks reducing new lending and failing to renew old loans.[10] Effects on bank credit will of course be more likely if banks have few securities in their asset portfolios. If firms are unable to substitute from bank loans to other sources of credit, or to retentions, then their real behaviour will be affected by this contraction of bank credit to an extent which will differ from that which would be generated by the money channel alone. By contrast, if they were able to substitute into securities, they would only face the interest rate effect of monetary policy.

The bank lending channel emphasises the effects a change in monetary policy has on supply and demand for bank loans and potential asymmetry between the effects of positive and negative monetary shocks on final activity variables. An increase in the basic interest rate may result in a worsening in the financial position of banks, which could be caused either by a fall in deposits or as a result of financial losses by the lender in other markets, leading to a reduction in the supply of credit. Even lacking this effect, banks with relatively opaque assets are more likely to have to pay higher prices for deposits (Kashyap and Stein 1999). Banks are constrained by the requirements to keep a minimum capital to risk-weighted assets ratio of 8% or greater by international agreement, so if they are close to this ratio then it follows that they cannot increase their supply of credit without first attracting a new stock of deposits. Effects of monetary policy tightening on capital may help to rationalise the separate credit channel (Rapullo and Suarez 2000). There is also an increased risk of banks failing as a result of increasingly tight monetary policy through a combination of a run on deposits and an increase in the number of loan defaults. In contrast, there is likely to be no corresponding change in risk when interest rates fall. Consequently there is not likely to be a corresponding increase in aggregate demand funded by credit growth.

[9]The former are held for yield, and the latter for liquidity.
[10] If loans and securities were perfect substitutes, banks would merely sell securities to maintain loan volumes.

Our focus is on the second aspect of the credit channel, namely the response of spending to bank loan supply changes[11]. One way to test for an effect of bank credit on expenditure would be to use an aggregate investment function and test for separate credit or liquidity effects. This is the approach adopted in this paper. But it does meet a "representative firm" difficulty, namely that it mixes firms whose behaviour may differ sharply. Accordingly, much empirical work has disaggregated by firm size, which avoids this problem and has the added advantage that the banks' balance sheet constraint and resultant collinearity between deposits and loans is no longer operative. For example, Gertler and Gilchrist (1994) found a larger role for bank credit in explaining inventory fluctuations for small firms than large ones, as well as a larger and speedier impact of monetary policy on small firms' expenditure and borrowing. They attributed these patterns to the credit channel, interacting with the high costs faced by small firms in switching sources of credit; lower value put on relationships with small firms by banks, and financial weakness of small firms. These factors imply small firms are the first to be credit rationed. Gertler and Gilchrist (1992) observed a perverse increase in loans for large companies following a monetary tightening, while there is an immediate reduction for small firms. They attribute this to large firms meeting cash flow shortages by both running down "buffer stock" deposits and increasing loans. With small firms facing higher costs of access to credit, such distress borrowing is not such a possibility.

Complementing these results, Kashyap et al (1994) show that bank-dependent firms lacking bond ratings and with low liquidity are most likely to cut inventories in periods of monetary tightness[12]. Morgan (1994) found sizeable increases in loans made under commitment, likely to be held by larger and stronger borrowers, during periods of tight money. Research by Bernanke (1993) shows that loans made at sizeable spreads relative to US prime rate, to small and risky firms, shrinks as a proportion of total loans as monetary policy becomes restrictive. Finally in Japan, Hoshi et al (1993) have shown that liquidity is more important for the investment by firms that do not have a main bank link during periods of tight money, and that the credit mix is a significant determinant of investment and inventories.

[11] On the response of bank lending to monetary policy, see Kashyap and Stein (1999) and their references.

[12] Similarly, Bernanke, Gertler and Gilchrist (1996) found using panel data that both small and bank dependent firms had more procyclical inventories than other firms did, a pattern they attributed to agency costs.

4. Empirical results.

In this section we test empirically to see whether the composition of external finance by the corporate sector has any significant effects on business investment. We utilise data on the G7 countries to test our proposition and find promising results from the addition of a debt-equity ratio (which is an indicator of the key financial accelerator variable, corporate net worth) and for a share of bank lending in debt finance (which is a proxy for the credit channel) into a set of basic investment functions.

In Section 3 we reviewed the literature on investment with particular reference to the dominant two models normally used as a basis for investigating the determinants of investment empirically. The neo-classical model implies that investment is dependent on the level of output and the user cost of capital, whereas the Tobin's Q models stress the importance of the financial value of the firm relative to the replacement cost of the investment. Our empirical work in this section incorporates both these effects into our basic investment functions and then augments these basic specifications with external financing variables, to ascertain whether there is any additional information available for explaining investment in indicators of the cost or composition of external finance to the corporate sector. We believe this approach is the best way of ensuring that significant results concerning external finance variables are providing an additional insight into investment behaviour beyond the explanations of all the standard investment theories employed currently. We allow the data to determine our optimum equation specifications for each country. The estimation of long and short run effects is undertaken simultaneously by an error-correction specification , and not by the Granger-Engel two step method.

We estimated aggregate business investment equations using quarterly data for the G7 countries, namely US, Canada, Japan, UK, Germany, France and Italy. Business investment, business sector output and the business sector capital stock data were taken primarily from the OECD business sector database. Note that a key aspect of these definitions compared with aggregate private investment is that the latter includes housing investment and the stock of housing, which has a different cyclical pattern, while the former overcomes problems of transfer from public ownership by including business sector capital, investment and output regardless of sector of ownership. Data on the composition of external finance in the non-financial corporate sector was constructed using the stock of outstanding assets and liabilities in the financial accounts published by the various national statistical agencies. Note that apart from the equity stock, these data are nominal fixed and hence the difference of the stock is close to the flow. The capital stock used in Tobin's Q is for the non-financial corporate sector

and not the business sector, to ensure consistency with the equity stock. Details of the construction of all the variables used in the empirical estimation are included in the accompanying data appendix.

We follow Bean (1981), Driver and Moreton (1991) and Darby, Hughes-Hallet, Ireland and Piscitelli (1999) in estimating dynamic error correction models of investment including both dynamic and long-run terms in *average q* and the real user cost of capital and dynamic terms in output and investment. Consistent with these authors, we also include one long-run term ensuring homogeneity between investment and output as implied by the CES production function and a further term ensuring a constant capital to output ratio in the long-run. Beginning with a general specification including four lags of all the dynamic terms as well as the first lag of the long run terms, we follow a general-to-specific modelling strategy to reduce these equations to a set of data-determined parsimonious specifications by omitting all insignificant terms. We ensure that the F-test for model simplifications are satisfied at all stages and that our equations have satisfactory residual diagnostic properties.

The final basic investment equations we arrived at for our set of seven countries are presented in Table 1. All variables are in logs and all estimation is performed using OLS. The fastest adjustment of investment to output occurs in France and the UK, with estimated adjustment parameters of around 0.23 and 0.17 per quarter respectively. The slowest adjustment appears to occur in the US, with an estimated adjustment parameters of only 0.05 and in Italy with an estimated parameter of only 0.08. The long-run adjustment variable between the capital stock and output is significant in the UK and France, with the speed of adjustment parameter three times greater in France than the UK (0.5 compared to 0.13). We find a role for the long run effect of Tobin's Q in Japan and France. Nowhere is the user cost of capital significant.

Table 2 presents the estimation results from augmenting the basic investment equations with both long run and dynamic terms in the debt to equity ratio variable. This is consistent with the operation of the financial accelerator, as the debt-equity ratio indicates the level of the net worth of the corporate sector at market values. The higher the debt-equity ratio, the higher moral hazard and other agency problems and hence the more likely is credit rationing to take place. Note however that a high debt equity ratio may also indicate a need for owners of firms to themselves reduce the proportion of debt in the balance sheet to avoid bankruptcy, i.e. there may also be a demand side factor at work.

Table 1: OLS Estimation Results of Basic Investment Equations.

	US[1]		Canada[2]		Japan[3]		UK[4]		Germany[5]		France[6]		Italy[7]	
Sample	1970Q4 – 1999Q4		1969Q4 – 1999Q4		1970Q2 – 1998Q2		1969Q4 – 1996Q4		1968Q2 – 1998Q4		1978Q1 – 1997Q1		1971Q2 – 1998Q3	
Constant	-0.162	(0.0538)	-0.344	(0.077)	-0.115	(0.0227)	-0.389	(0.1202)	-0.189	(0.0442)	0.035	(0.0446)	-0.166	(0.029)
Δlib(-1)			0.281	(0.0795)	0.193	(0.0589)							0.345	(0.0567)
Δlib(-2)					0.268	(0.0548)								
Δlib (-3)														
Δlib(-4)							0.167	(0.0735)						
Δlyb	1.057	(0.134)			0.925	(0.1102)			1.793	(0.1339)	2.051	(0.1806)	1.521	(0.1572)
Δlyb(-1)	0.484	(0.1346)							0.509	(0.1338)				
Δlyb(-2)	0.46	(0.1348)												
Δlyb(-3)	0.479	(0.1323)												
Δlyb(-4)														
Δlaveq														
Δlaveq(-1)					-0.032	(0.0138)								
Δlaveq(-2)														
Δlaveq(-3)														
Δlaveq(-4)														
Δluser														
Δluser(-1)									-0.068	(0.0286)				
Δluser(-2)														
Δluser(-3)														
Δluser(-4)														
Lib-lyb(-1)	-0.047	(0.02)	-0.126	(0.0277)	-0.078	(0.0155)	-0.168	(0.0427)	-0.091	(0.0216)	-0.237	(0.0404)	-0.085	(0.0154)
Lkb-lyb(-1)							-0.135	(0.0435)			-0.492	(0.0847)		
Laveq(-1)					0.016	(0.0034)					0.023	(0.0041)		
Luser(-1)														
R^2	0.661		0.374		0.778		0.452		0.715		0.802		0.721	
LM4 Test: $X^2(4)$=	2.892	[0.576]	6.802	[0.147]	2.984	[0.560]	5.262	[0.261]	5.242	[0.763]	7.974	[0.093]	2.851	[0.583]
RESET: $X^2(1)$=	2.958	[0.085]	3.251	[0.071]	1.944	[0.163]	0.073	[0.788]		[0.460]	0.083	[0.773]	0.159	[0.690]
Normality: $X^2(2)$=	2.144	[0.342]	0.177	[0.915]	2.566	[0.277]	0.84	[0.657]	1.538	[0.463]	0.084	[0.959]	0.547	[0.761]
Hetero: $X^2(1)$=	1.349	[0.246]	0.963	[0.756]	0.113	[0.737]	3.132	[0.077]	1.038	[0.308]	0.121	[0.728]	0.76	[0.383]

Dependent variable is Δlib. Standard errors are presented in parentheses. Probabilities for diagnostic tests are presented in squared brackets. Variable definitions are included in the data appendix.

1. Estimation for US includes a trend and a 0,1,0 dummy for 81q4 and 98Q1.
2. Estimation for Canada includes a trend, a 0,1,-1,0 dummy for 76q3-76q4 and a 0,1,0 dummy for 91q2.
3. Estimation for Japan includes 0,1,-1,0 dummies for 72q1-72q2, 73q3-74q1, 78q4-79q2, and 89q1-89q2, and a 0,1,0 dummy for 80q2.
4. Estimation for the UK includes 0,1,-1,0 dummies for 73q1-73q2, 77q1-77q2 and 85q1-85q2.
5. Estimation for Germany includes a 0,1,-1,0 dummy for 84q2-84q3 and 0,1,0 dummies for 76q1, 76q3, 84q1 and 98q2.
6. Estimation for France includes a 0,1,-1,0 dummy for 85q1-85q2 and a 0,1,0 dummy for 79q1.
7. Estimation for Italy includes 0,1,0 dummies for 72q3, 73q1, 74q3, 83q1 and 85q1.

Table 2: OLS Estimation Results for Investment Equations Including Stock of Debt to Equity Ratio Variables.

	US		Canada		UK		France		Germany	
Sample Period	1970Q4 – 1999Q4		1970Q4 – 1998Q4		1969Q4 – 1996Q4		1978Q1-1997Q1		1968Q2 – 1998Q4	
Constant	-0.192	(0.0544)	-0.343	(0.0749)	-0.425	(0.119)	-0.02	(0.0423)	-0.195	(0.0437)
Δlib(-1)			0.207	(0.0818)						
Δlib(-2)										
Δlib (-3)										
Δlib(-4)					0.156	(0.0721)				
Δlyb	0.998	(0.134)					1.973	(0.173)	1.756	(0.1334)
Δlyb(-1)	0.43	(0.1342)							0.484	(0.1327)
Δlyb(-2)	0.435	(0.1328)								
Δlyb(-3)	0.471	(0.1299)								
Δlyb(-4)										
Δlaveq										
Δlaveq(-1)										
Δlaveq(-2)										
Δlaveq(-3)										
Δlaveq(-4)										
Δluser										
Δluser(-1)									-0.062	(0.0284)
Δluser(-2)										
Δluser(-3)										
Δluser(-4)										
Δldebteqr										
Δldebteqr (-1)										
Δldebteqr (-2)							0.027	(0.0127)		
Δldebteqr (-3)										
Δldebteqr (-4)										
Lib-lyb(-1)	-0.058	(0.0202)	-0.121	(0.0269)	-0.127	(0.036)	-0.245	(0.0359)	-0.1	(0.0219)
Laveq(-1)										
Lkb-lyb(-1)							-0.476	(0.0707)		
Luser(-1)										
Ldebteqr(-1)	-0.011	(0.0049)	-0.079	(0.0288)	-0.029	(0.0075)	-0.032	(0.0049)	-0.019	(0.0093)
R^2	0.677		0.413		0.474		0.825		0.724	
LM4 Test: $X^2(4)$=	2.157	[0.707]	5.797	[0.215]	4.332	[0.363]	5.824	[0.213]	3.529	[0.473]
RESET: $X^2(1)$=	2.494	[0.114]	0.747	[0.387]	0.0133	[0.908]	0.947	[0.330]	1.848	[0.174]
Normality: $X^2(2)$=	1.195	[0.550]	0.706	[0.703]	1.389	[0.499]	2.076	[0.354]	3.337	[0.189]
Hetero: $X^2(1)$=	0.803	[0.370]	0.652	[0.419]	2.064	[0.151]	0.367	[0.545]	0.587	[0.444]

Note: None of the additional terms were significant for France or Italy. So the best fitting specification remained the parsimonious case for each country presented in the previous table. The debt equity ratio is defined as the stock of outstanding loans plus bonds divided by the stock of outstanding equities. Dependent variable is Δlib. Standard errors are presented in parentheses. Probabilities for diagnostic tests are presented in squared brackets. Variable definitions are included in the data appendix.

We find evidence to suggest that the long-run level of investment is reduced when the debt to equity ratio increases in the US, Canada, the U.K, France and Germany. The size of the effect appears to be similar in both the North American and European countries, with the exception of Canada where the effect is three times as great as in any other country. The original variables included in the investment equations retain approximately the same values and significance as we found in our basic equations. This suggests the original specification is fairly robust. None of the additional terms were significant in Italy or Japan.

Next we tested for evidence of credit channel effects via the inclusion of the loans to debt ratio as a measure of the importance of bank lending in overall debt. These results are reported in Table 3. Using this definition, we find significant evidence of a long-run negative effect in both the U.S and Japan, i.e. investment is lower when bank loans are a higher proportion of debt, as is likely to occur in a recession. Most likely this would occur in recession. The estimated adjustment effect is of a similar magnitude in both countries at around 10 per cent per quarter.

Finally, we sought to test the corollary of the financial accelerator theory; namely that weak corporate balance sheets should have a greater impact during downturns in the business cycle when flows of external finance to the corporate sector may become restricted. We tested whether this effect is significant by conditioning the estimated coefficients for the debt to equity ratios on the state of the business cycle. We constructed dummy variables that take the value 1 during recessionary periods over the sample periods used in our estimation and 0 during all other periods. We identified recessionary periods as those where the quarterly change in industrial production was negative for two continuous periods or more[13]. Our results are presented in Table 4. Only in Canada do we find significant evidence that the debt equity ratio has an additional negative impact on investment during recessionary periods, though the estimated co-efficient is only marginally insignificant in France. During these periods the impact of the debt to equity ratio on investment is around a third greater.

[13] We repeated the exercise for the US using the NBER business cycle turning points, but the results were unchanged.

Table 3: OLS estimation results for investment equations including loans to debt ratio variables.

	US		Japan	
Sample Period	1970Q4 – 1999Q4		1970Q2 – 1998Q2	
Constant	-0.176	(0.0528)	-0.142	(0.0261)
Δlib(-1)			0.203	(0.0583)
Δlib(-2)			0.29	(0.055)
Δlib (-3)				
Δlib(-4)				
Δlyb	1.024	(0.1313)	0.991	(0.1132)
Δlyb(-1)	0.465	(0.1317)		
Δlyb(-2)	0.454	(0.1315)		
Δlyb(-3)	0.463	(0.1292)		
Δlyb(-4)				
Δlaveq				
Δlaveq(-1)			-0.031	(0.0137)
Δlaveq(-2)				
Δlaveq(-3)				
Δlaveq(-4)				
Δluser				
Δluser(-1)				
Δluser(-2)				
Δluser(-3)				
Δluser(-4)				
Δllnsdbt				
Δllnsdbt (-1)				
Δllnsdbt (-2)				
Δllnsdbt (-3)				
Δllnsdbt (-4)				
Lib-lyb(-1)	-0.04	(0.0197)	-0.088	(0.016)
Laveq(-1)			0.011	(0.0042)
Luser(-1)				
Llnsdbt(-1)	-0.052	(0.0207)	-0.072	(0.0352)
R^2	0.681		0.787	
LM4 Test: $X^2(4)$=	1.483	[0.830]	4.359	[0.360]
RESET: $X^2(1)$=	1.62	[0.203]	0.333	[0.564]
Normality: $X^2(2)$=	2.376	[0.305]	2.052	[0.358]
Hetero: $X^2(1)$=	1.335	[0.248]	0.073	[0.787]

Note: None of the additional terms were significant for the remaining countries. The loans to debt ratio is defined as the stock of outstanding loans divided by the stock of outstanding loans plus bonds. Dependent variable is Δlib. Standard errors are presented in parentheses. Probabilities for diagnostic tests are presented in squared brackets. Variable definitions are included in the data appendix.

Table 4: OLS Estimation Results for Investment Equations Including Stock of Debt to Equity Ratio Variables conditioned on the state of the business cycle.

	US		Canada		UK		France		Germany	
Sample Period	1970Q4 – 1999Q4		1970Q4 – 1998Q4		1969Q4 – 1996Q4		1978Q1-1997Q1		1968Q2 – 1998Q4	
Constant	-0.187	(0.0558)	0.017	(0.0039)	-0.418	(0.118)	-0.026	(0.0416)	-0.198	(0.0448)
Δlib(-1)			0.162	(0.0825)						
Δlib(-2)										
Δlib (-3)										
Δlib(-4)					0.152	(0.0715)				
Δlyb	0.989	(0.1365)					2.081	(0.1788)	1.779	(0.1469)
Δlyb(-1)	0.405	(0.1483)							0.492	(0.1348)
Δlyb(-2)	0.418	(0.1399)								
Δlyb(-3)	0.458	(0.1343)								
Δlyb(-4)										
Δlaveq										
Δlaveq(-1)										
Δlaveq(-2)										
Δlaveq(-3)										
Δlaveq(-4)										
Δluser										
Δluser(-1)									-0.059	(0.0291)
Δluser(-2)										
Δluser(-3)										
Δluser(-4)										
Δldebteqr							0.029	(0.0125)		
Δldebteqr (-1)										
Δldebteqr (-2)										
Δldebteqr (-3)										
Δldebteqr (-4)										
Lib-lyb(-1)	-0.057	(0.0205)	-0.092	(0.0293)	-0.125	(0.0357)	-0.269	(0.0375)	-0.102	(0.0224)
Laveq(-1)										
Lkb-lyb(-1)							-0.521	(0.0731)		
Luser(-1)										
Ldebteqr(-1)	-0.011	(0.0049)	-0.064	(0.029)	-0.028	(0.0075)	-0.034	(0.0049)	-0.019	(0.0095)
Ldebteqr(1)*dum	0.004	(0.0108)	-0.194	(0.0838)	0.018	(0.0106)	-0.006	(0.003)	0.002	(0.0051)
R^2	0.677		0.44		0.489		0.834		0.725	
LM4 Test: $X^2(4)$=	2.201	[0.699]	3.462	[0.484]	2.846	[0.584]	6.45	[0.168]	3.566	[0.468]
RESET: $X^2(1)$=	2.168	[0.141]	0.006	[0.935]	0.175	[0.676]	0.126	[0.722]	1.639	[0.200]
Normality: $X^2(2)$=	1.363	[0.506]	2.836	[0.242]	1.099	[0.577]	1.963	[0.375]	3.129	[0.209]
Hetero: $X^2(1)$=	0.785	[0.376]	0.182	[0.670]	1.602	[0.206]	0.544	[0.461]	0.656	[0.418]

Note: The downturn dummy periods were identified as those periods when the quarterly change in industrial production is negative for two consecutive quarters. The exercise was repeated for the US using the peak to trough periods identified in the NBER business cycle program, but the results were unaltered. Dependent variable is Δlib. Standard errors are presented in parentheses. Probabilities for diagnostic tests are presented in squared brackets. Variable definitions are included in the data appendix.

Table 5 provides a summary of the results. It can be seen that the financial effects are widespread within the G-7, only Italy has a traditional specification with just real variables entering. Particularly notable is the widespread effect of the debt-equity ratio, implying that the financial accelerator or net worth channel, linked to credit rationing and "precautionary" variations in credit demand is of widespread importance at a macro level. The results for the UK, Germany and France are particularly close in magnitude, despite the different financing structures in those countries that were demonstrated in the charts. Note, however, that these are in effect long run coefficients, with the short run effect depending on the differing dynamic adjustment processes in the equations. Perhaps unsurprisingly, the credit channel as indicated by the ratio of loans to debt is less widespread, featuring only in the US and Japan where nonbank sources of funds are relatively well developed. As shown in Charts 4A and 4B, the bank loans to debt ratios in Germany, France and Italy are close to 1, thus giving little movement in this ratio. Moreover, as we saw in Section 3, much of the empirical work on the credit channel up to this point, has been conducted on micro data or small firms, with effects at a macro level being potentially obscured by the offsetting responses of large firms.

Table 5: Summary of results (significant coefficients indicating financial effects on investment)

	US	Canada	Japan	UK	Germany	France	Italy
Tobin's Q			0.016			0.023	
Debt/ Equity	-0.011	-0.079		-0.029	-0.019	-0.032	
Loans/ Debt	-0.052		-0.072				
Asymmetric Business cycle effect on debt/equity		-0.194				-0.006	

5. Conclusions.

This paper has presented estimates of investment functions for the G7 countries where a number of financial variables, consistent with the valuation ratio, financial accelerator and credit channel approaches, have proven to be relevant determinants of business fixed investment. The results highlight the oversimple nature of basic investment specifications; while also indicating a wider incidence of these financial effects on investment than the

existing literature, focused as it is on the US, would otherwise indicate. On the other hand, there is a clear divide in that financial effects on investment appear to be more widely detectable in the US and Canada than elsewhere.

These results support, for a much wider range of countries, the earlier evidence by Bernanke et al (1996), Oliner and Rudebusch (1996) and Hu (1999) that identified the financial accelerator as a significant influence on investment behaviour in the US. Our results also concur with those reported by Vermuelen (2000) who used firm balance sheet data to show that the financial accelerator effect has a significant effect in the main European countries. However, in general, we do not find evidence using aggregate level data of an asymmetry in the effect that is dependent on the state of the business cycle as suggested by Vermuelen.

There is also evidence of credit channel effects affecting investment at an aggregate level in the US and Japan, with the bank loan/total lending ratio being significant. This is consistent with work on micro data by authors such as Kashyap et al (1994) and Gertler and Gilchrist (1994) on lending, inventories and/or investment for the US and Hoshi et al (1993) on the lending mix and investment in Japan. Elsewhere, in Canada and the EU-4, such credit channel effects are not detectable, suggesting that micro level effects for small firms are offset by the behaviour of large firms in aggregate data.

There are some implications for policymakers from these results. In the short term the strong effects of the debt-equity ratio on investment imply that ongoing declines in share prices in the G-7, together with debt accumulation, may lead to further sharp falls in fixed investment beyond those predicted on the basis of traditional variables, such as output and the capital stock. This is particularly relevant for the US. The effect of Tobin's Q detected in Japan suggests that expected profitability, as indicated by share prices, may account for a part of the weakness of investment, quite apart from any bank credit rationing which is indicated by the significant credit channel effect.

In the longer term, stronger financial effects on investment may emerge in Europe, as in the US, when European capital markets within the single currency area develop further. This applies notably to the financial accelerator in Italy and the credit channel in each of the EU-4. Until then, the differing strength of banks in different European countries may generate asymmetries in the transmission mechanism of ECB monetary policy (Kashyap and Stein 1999).

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Appendix: Unit root tests.

Canada: Sample 1969q4 to 1998q4.

Variable		DF Test Statistic		ADF Test Statistic		ADF lag length
lib	No trend	-0.984		-0.923		1
	Trend	-1.724		-2.702		2
Δlib	No trend	-8.092	*	-5.291	*	1
	Trend	-8.068	*	-5.279	*	1
lyb	No trend	-1.647		-1.264		1
	Trend	-1.963		-2.31		1
Δlyb	No trend	-7.58	*	-6.097	*	1
	Trend	-7.62	*	-6.149	*	1
laveq	No trend	0.177		-0.454		1
	Trend	-2.359		-2.834		1
Δlaveq	No trend	-7.046	*	-4.398	*	3
	Trend	-7.202	*	-4.619	*	3
luser	No trend	-2.298		-2.047		1
	Trend	-0.002		-0.445		1
Δluser	No trend	-7.82	*	-4.512	*	2
	Trend	-8.29	*	-5.007	*	2
ldebteqr	No trend	-2.637		-2.628		1
	Trend	-1.634		-1.665		1
Δldebteqr	No trend	-10.034	*	-7.0229	*	1
	Trend	-10.444	*	-7.454	*	1
llnsdbt	No trend	-3.027	*	-2.533		1
	Trend	-2.869		-2.291		1
Δllnsdbt	No trend	-13.66	*	-9.254	*	1
	Trend	-13.728	*	-9.369	*	1
linvy	No trend	-0.975		-1.092		1
	Trend	-1.887		-3.0898		3
lkky	No trend	-0.12		-0.446		1
	Trend	-1.528		-2.876		3

* Implies significant at the 5% level

France: Sample 1971q2 to 1997q4.

Variable		DF Test Statistic		ADF Test Statistic		ADF lag length
lib	No trend	-1.152		-1.157		1
	Trend	-1.594		-1.768		1
Δlib	No trend	-9.381	*	-5.988	*	1
	Trend	-9.363	*	-5.975	*	1
lyb	No trend	-3.158	*	-2.448		1
	Trend	-2.193		-3.118		1
Δlyb	No trend	-7.335	*	-4.877	*	1
	Trend	-7.699	*	-5.162	*	1
laveq	No trend	0.551		-1.337		1
	Trend	-2.155		-2.354		1
Δlaveq	No trend	-7.041	*	-6.738	*	1
	Trend	-7.181	*	-6.957	*	1
luser	No trend	-2.67		-2.294		1
	Trend	-0.646		-1.332		1
Δluser	No trend	-5.487	*	-5.088	*	1
	Trend	-5.95	*	-5.645	*	1
ldebteqr	No trend	0.331		-0.125		1
	Trend	-2.385		-2.57		1
Δldebteqr	No trend	-8.01	*	-6.38	*	1
	Trend	-8.159	*	-6.561	*	1
llnsdbt	No trend	0.713		0.731		1
	Trend	-1.65		-1.623		1
Δllnsdbt	No trend	-10.399	*	-6.946	*	1
	Trend	-10.565	*	-7.126	*	1
linvy	No trend	-1.541		-1.486		1
	Trend	-1.554		-1.5		1
lkky	No trend	-0.477		-1.018		1
	Trend	-2.319		-2.8		1

* Implies significant at the 5% level

Germany: Sample 1968q2 to 1998q4.

Variable		DF Test Statistic		ADF Test Statistic		ADF lag length
lib	No trend	-1.443		-1.503		1
	Trend	-2.015		-2.294		1
Δlib	No trend	-9.91	*	-6.868	*	1
	Trend	-9.904	*	-6.878	*	1
lyb	No trend	-1.187		-1.072		1
	Trend	-1.855		-2.1984		2
Δlyb	No trend	-9.432	*	-6.429	*	1
	Trend	-9.439	*	-4.573	*	2
laveq	No trend	1.071		0.139		1
	Trend	-0.854		-1.294		1
Δlaveq	No trend	-7.818	*	-6.496	*	1
	Trend	-8.216	*	-6.973	*	1
luser	No trend	-1.99		-2.293		1
	Trend	-0.27		-1.383		1
Δluser	No trend	-6.628	*	-5.867	*	1
	Trend	-6.945	*	-4.328	*	2
ldebteqr	No trend	-1.0		-0.237		2
	Trend	-1.047		0.132		2
Δldebteqr	No trend	-10.702	*	-9.846	*	1
	Trend	-10.982	*	-10.495	*	1
llnsdbt	No trend	-2.189		-2.383		1
	Trend	-2.179		-2.372		1
Δllnsdbt	No trend	-10.356	*	-7.277	*	1
	Trend	-10.312	*	-7.245	*	1
linvy	No trend	-2.108		-2.197		1
	Trend	-2.044		-2.134		1
lkky	No trend	-1.639		-1.606		1
	Trend	-1.426		-1.597		1

* Implies significant at the 5% level

Italy: Sample 1971q2 to 1998q3.

Variable		DF Test Statistic	ADF Test Statistic	ADF lag length
lib	No trend	-1.359	-1.512	1
	Trend	-2.357	-2.858	1
Δlib	No trend	-9.095	-6.365	1
	Trend	-9.067	-6.348	1
lyb	No trend	-2.892	-2.369	1
	Trend	-2.662	-2.978	1
Δlyb	No trend	-8.177	-6.038	1
	Trend	-8.481	-6.346	1
laveq	No trend	-0.994	-1.34	1
	Trend	-1.845	-2.203	1
Δlaveq	No trend	-8.368	-6.629	1
	Trend	-8.329	-6.592	1
luser	No trend	-2.885	-2.113	1
	Trend	1.223	-0.259	1
Δluser	No trend	-5.25	-4.954	1
	Trend	-5.825	-5.622	1
ldebteqr	No trend	-1.059	-1.385	1
	Trend	-1.592	-2.024	1
Δldebteqr	No trend	-8.152	-6.96	1
	Trend	-8.11	-6.916	1
llnsdbt	No trend	-0.635	-0.66	1
	Trend	-2.205	-2.333	1
Δllnsdbt	No trend	-10.047	-6.686	1
	Trend	-10.001	-6.656	1
linvy	No trend	-1.588	-1.779	1
	Trend	-1.51	-1.899	1
lkky	No trend	-0.693	-1.153	1
	Trend	-2.56	-0.994	1

* Implies significant at the 5% level

Japan: Sample 1969q4 to 1998q2.

Variable		DF Test Statistic	ADF Test Statistic	ADF lag length
lib	No trend	-0.55	-1.215	3
	Trend	-0.964	-2.378	2
Δlib	No trend	-5.956	-3.504	1
	Trend	-5.928	-3.468	1
lyb	No trend	-3.027	-2.704	1
	Trend	-0.067	-1.586	3
Δlyb	No trend	-8.611	-2.927	2
	Trend	-9.246	-3.427	2
laveq	No trend	-1.244	-1.878	3
	Trend	-0.856	-1.93	3
Δlaveq	No trend	-6.97	-4.185	2
	Trend	-6.983	-4.212	3
luser	No trend	1.559	0.881	1
	Trend	-0.007	-0.338	1
Δluser	No trend	-8.152	-3.96	2
	Trend	-8.856	-7.396	1
ldebteqr	No trend	-1.748	-1.988	1
	Trend	-1.448	-1.985	1
Δldebteqr	No trend	-7.88	-4.92	2
	Trend	-7.895	-4.974	2
llnsdbt	No trend	-0.101	-0.007	1
	Trend	-1.86	-1.783	1
Δllnsdbt	No trend	-11.286	-6.083	1
	Trend	-11.271	-6.042	1
linvy	No trend	-1.048	-2.05	2
	Trend	-2.165	-2.674	2
lkky	No trend	-2.012	-0.731	3
	Trend	-2.654	-2.599	3

* Implies significant at the 5% level

United Kingdom: Sample 1969q4 to 1996q4.

Variable		DF Test Statistic	ADF Test Statistic	ADF lag length
lib	No trend	-0.376	-0.252	1
	Trend	-1.944	-1.724	1
Δlib	No trend	-11.722	-7.424	1
	Trend	-11.685	-7.402	1
lyb	No trend	0.501	0.448	1
	Trend	-1.596	-1.7	1
Δlyb	No trend	-9.842	-6.727	1
	Trend	-9.856	-6.755	1
laveq	No trend	-0.332	-0.631	1
	Trend	-2.092	-2.153	1
Δlaveq	No trend	-8.555	-6.724	1
	Trend	-8.763	-6.977	1
luser	No trend	-2.574	-2.282	1
	Trend	-0.922	-1.193	1
Δluser	No trend	-8.003	-7.218	1
	Trend	-8.331	-7.685	1
ldebteqr	No trend	-1.067	-1.621	1
	Trend	-2.526	-2.993	1
Δldebteqr	No trend	-7.809	-6.38	1
	Trend	-7.846	-6.801	1
llnsdbt	No trend	-2.158	-2.373	2
	Trend	-1.113	-1.732	2
Δllnsdbt	No trend	-7.003	-4.575	1
	Trend	-7.407	-4.905	1
linvy	No trend	-2.443	-1.903	1
	Trend	-3.565	-2.853	1
lkky	No trend	-0.826	-0.932	1
	Trend	-1.828	-2.025	1

* Implies significant at the 5% level

United States: Sample 1966q2 to 1999q4.

Variable		DF Test Statistic	ADF Test Statistic	ADF lag length
lib	No trend	1.601	0.757	1
	Trend	-0.703	-2.948	2
Δlib	No trend	-7.16	-5.103	1
	Trend	-7.264	-5.208	1
lyb	No trend	0.692	0.547	1
	Trend	-2.128	-2.976	1
Δlyb	No trend	-8.993	-6.47	1
	Trend	-9.002	-6.479	1
laveq	No trend	2.039	1.157	1
	Trend	-0.999	-1.324	1
Δlaveq	No trend	-8.581	-7.294	1
	Trend	-9.077	-7.923	1
luser	No trend	-2.316	-2.031	1
	Trend	-1.019	-1.399	1
Δluser	No trend	-8.09	-6.925	1
	Trend	-8.276	-7.163	1
ldebteqr	No trend	-1.352	-1.445	1
	Trend	-1.022	-1.086	1
Δldebteqr	No trend	-10.651	-8.295	1
	Trend	-10.971	-8.7	1
llnsdbt	No trend	-0.699	-1.456	2
	Trend	-1.178	-1.807	2
Δllnsdbt	No trend	-10.559	-4.662	4
	Trend	-10.585	-4.689	4
linvy	No trend	1.06	0.108	1
	Trend	-0.701	-2.247	2
lkky	No trend	-1.823	-2.299	2
	Trend	-1.835	-2.269	1

* Implies significant at the 5% level

Appendix: Variable definitions.

Unless stated otherwise all the quarterly data for Business investment, output, the capital stock and the deflator for business output all come from the OECD business sector database, release version: 2000:2. The share price indices for all countries were taken from the OECD Main Economic Indicators country tables.

All variables are in logs.

Lib: Business investment: OECD Business sector database. Except for the US and UK where data from national statistical sources was used.

Lyb: Business sector output: OECD business sector database.

Laveq: For all countries: Average Q = Share Price Index / Capital Stock. Where capital stock is taken as the corporate capital stock at current prices from National data sources where available (sources detailed below).

Luser: Real user cost of capital. The user cost of capital series was generated using the business sector and output deflators, the depreciation rate, real interest rate and the effective corporate tax rate.

Ldebteqr: debt to equity ratio = (loans + bonds)/shares. Data sources for financial balance sheet items are detailed below

Llns: Bank loans as a proportion of total liabilities = loans/(loans+bonds+shares).

Lbnds: Bonds as a proportion of total liabilities.

Llnsdbt: Bank loans as a proportion of total debt (loans plus bonds).

Linvy: ratio of investment to putput

Lkky: ratio of capital stock to output

Sources for data

All countries

Investment, output and capital stock data for the business sector are from the OECD business sector database (except capital stock for "q", see country sections below).

United States.

Financial and capital stock variables for the non-farm non-financial corporate sector (used in "q") come from the Balance sheet and Flow of funds data available on a quarterly basis from the Federal Board of Governors website:
http://www.federalreserve.gov/releases/z1/current/data.htm

Japan.

Financial variables for the corporate sector come from the Flow of Funds data available on a quarterly basis from the Bank of Japan website: http://www.boj.or.jp/en/siryo/siryo_f.htm. The capital stock for the nonfinancial corporate sector (used in "q") is derived from the "Annual Report on National Accounts" published by the Economic Planning Agency.

Canada.

Financial variables and the capital stock for the corporate sector (used in "q") come from the Flow of Funds data available on an annual basis from Statistics Canada. Data on flows is available on a quarterly basis and was used to interpolate the annual series for bonds, loans and shares into quarterly data.

United Kingdom.

Financial variables for the corporate sector come from the balance sheet data available on a quarterly basis from the Office of National Statistics and published in "Financial Statistics". It is also available in "Timezone" website http://www.statistics.gov.uk/statbase/timezone.asp. The data for the capital stock of the private non financial company sector (used in "q") are as published in "National Income and Expenditure".

Germany.

Financial variables for the corporate sector come from the annual article on the flow of funds published in the Deutsche Bundesbank Monthly Review, while the capital stock for the corporate sector (productive enterprises excluding housing) (used in "q") are from the "Volkswirtschaftliche Gesamtrechnung" published in the "Statistisches Jahrbuch" of the

Federal Statistics Office. Quarterly series were generated by interpolating the annual data. The loans data were interpolated in line with the growth rates of Banking sector domestic credit: claims on other residents, from the IMF's International Financial Statistics. Bonds data was interpolated linearly. Equity data was interpolated in line with the growth rates of the share price index.

France.

Financial variables for the corporate sector come from the Flow of Funds data available on an annual basis from the Banque de France website: Data for the capital stock (used in "q") are derived from the "Compte de Patrimoine" produced by INSEE and published in the "Annuaire Statistique de la France". Quarterly series were generated by interpolating the annual data. The loans data were interpolated in line with the growth rates of Banking sector domestic credit: claims on other residents, from the IMF's International Financial Statistics. Bonds data was interpolated linearly. Equity data was interpolated in line with the growth rates of the share price index.

Italy.

Financial variables for the corporate sector come from the Flow of Funds data available on a quarterly basis from the Banca d'Italia website: Quarterly series were generated by interpolating the annual data. The loans data were interpolated in line with the growth rates of Banking sector domestic credit: claims on other residents, from the IMF's International Financial Statistics. Bonds data was interpolated linearly. Equity data was interpolated in line with the growth rates of the share price index.