Cycles and Corporate Investment: Direct Tests Using Survey Data on Banks’ Lending Practices

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Abstract
Microeconomic studies have found cash flow to be important for the investment decision and this result is often interpreted as evidence of adverse selection in credit markets. Using direct survey evidence on banks’ willingness to lend, this research examines the role of credit in the investment decision while allowing for cash-flow, Tobin’s q, income, uncertainty and default risks. Regression analysis reveals that banks’ willingness to lend, income and uncertainty are the key drivers of cyclical fluctuations in corporate investment. These results have important implications for the conduct of monetary policy as well as research on business cycles.

Key words: credit constraints, corporate investment, Tobin’s q
JEL classification: E22, E5

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1. Introduction

In the conventional Tobin’s q model corporate investment is driven entirely by Tobin’s q while demand, uncertainty, cash flow and credit play no role for the investment decision (Hayashi, 1982). However, empirical evidence suggests that corporate investment is only weakly related to Tobin’s q while income and, particularly, cash flow appear to be the principal force behind fluctuations in investment (see for discussion Blanchard, Rhee and Summers, 1993, and Romer, 2006, Ch. 8). Using microeconomic evidence, most of the investment literature finds a strong link between investment and cash flow or other measures of internal funds and interprets it as evidence of credit market imperfections. “Indeed, for most part the literature on financial market imperfections is one of unusual empirical consensus” (Romer, 2006, p 430).

There are, however, three problems associated with this interpretation of nexus between investment and cash flow. First, cash-flow is not always an important determinant of investment in macroeconomic studies. Greasley and Madsen (2006), for example, find that the importance of cash-flow in determining investment diminishes substantially once uncertainty is allowed for in the regressions.

Second, if cash-flow does indeed proxy credit constraints, it does not reveal the type of credit constraint that is relevant for the investment decision. Almost all the empirical cash-flow literature interprets the positive influence of cash-flow on investment as evidence for the adverse selection hypothesis (Bernanke, Gertler and their collaborators; see for overview Bernanke, 1983, and Romer, 2006). In the models interpreting these findings, lenders have the capacity to distinguish the risk characteristics of potential borrowers and can optimally price each borrower’s investment proposition such that reduced lending only occurs as a result of borrowers being priced out of the market as opposed to being rationed out. In other words, the interest rates charged by banks vary from firm to firm depending on the riskiness of the investment project. However, while often implied from the results, microeconomic cash-flow regressions do not give information about how credit influences investment. In particular, whether credit dynamics are important because they function to price firms out of the market or because they create incentives to restrain the quantity of credit able to be accessed by firms cannot be ascertained from the empirical tests. In the models of Stiglitz and Weiss (1981), Blinder (1987), and Stiglitz (1988), banks cannot distinguish good from bad borrowers. Thus, it is optimal for banks to constrain the quantity of credit in times of high
expected default rates. Whether some firms are priced out of the market or most firms are 
credit constrained have markedly different policy implications.

Third, cash-flow regressions are consistent with several other theories of investment 
in which credit does not play an explicit role. Steigum (1983) and Blanchard, Rhee and 
Summers (1993) propose that if firms act in the interest of new stock holders they should 
follow the fundamental value of stocks when they make their investment decision, where the 
fundamental value of stocks is reflected in cash-flows. Similarly, Romer (2006, Ch. 8) argues 
that firms with high cash flow may have low costs or produce successful products and, 
therefore, have strong incentives to expand their production capacity quite independently of 
credit constraints. Kaplan and Zingales (1997) show that the positive relationship between 
investment and cash flow is not necessarily increasing in the degree of financing constraints 
but reflects precautionary savings motives, overly risk-averse managers or managers who 
otherwise choose to finance investment from internal cash flows. Their empirical estimates of 
the relationship between cash-flow and credit constraints reveal a negative correlation 
between the sensitivity of investment to cash flow and financing constraints. Finally, 
Carlstrom and Fuerst (1997) devise a model where productivity cycles and the distribution of 
wealth between lenders and entrepreneurs are the drivers of the investment cycle, and agency 
costs in financial markets are a by-product. In this case a positive relationship between cash 
flow and investment could exist, but there is not necessarily a causal relationship between the 
two.

Overall, although the financial market imperfection hypothesis is intuitive appealing, 
the tests using cash flow do not test the theory in its own right. Furthermore, the 
microeconomic evidence, in itself open to debate, is not confirmed by corresponding 
macroeconomic evidence that relates investment with imperfections in the financial markets.

This paper seeks to overcome these concerns by using a direct measure of the 
availability of credit for private corporate investment, namely survey evidence on banks’ 
willingness to lend. This measure is an excellent measure of the availability of credit because 
it directly measures the degree to which firms are credit constrained on a macroeconomic 
level and no indirect measures are needed in the regression analysis. To our best knowledge, 
this is the first paper to consider the influence of banks’ willingness to lend on corporate 
investment. Not only does banks’ willingness to lend circumvent previous concerns regarding 
the causal relationship between finance constraints and the sensitivity of investment to cash
flow, it enables one to test this at an aggregate level and, as such, gives clear macro predictions about the relationship between investment and the supply of credit.

Moreover, capturing the relative ease of credit access to firms for investment, banks’ willingness to lend permits one to verify the form of market imperfections. In particular, this analysis allows a distinction as to whether it is the supply of credit at given terms constraining investment or whether the external premium on financing firm investment simply prices firms out of the finance market. The data also overcome the problems of using credit aggregates as proxies for credit availability. The volume of aggregate credit is determined by both supply and demand. In a state of low credit demand, credit may be reflected in low credit aggregates even if banks are willing to lend out (Jaffee and Modigliani, 1969). Furthermore, even if credit has been tightened, the aggregate credit often continues to increase because credit lines are extended for firms experiencing declining cash flow so as lenders can avoid bankruptcy costs (Jaffee and Modigliani, 1969).

Fundamentally, this research addresses the important questions in the literature on investment, namely; 1) what explains the often-found strong link between investment, cash flow and income; 2) are capital market imperfections influential for investment because of quantity constraints as predicted by the model of Stiglitz and Weiss (1981), or because some borrowers are priced out of the market due to increased costs of credit provision; 3) what are the driving forces behind the large investment fluctuations observed at the macro level; and 4) are credit market imperfections important for investment fluctuations once income, cash flow, and uncertainty are allowed for in the regressions?

The next section gives informal evidence on the relationship between investment, Tobin’s $q$, the profit rate and uncertainty. Section 3 extends the conventional Tobin’s $q$ framework to allow for demand and credit constraints. Section 4 estimates the relationship between investment, credit constraints, and Tobin’s $q$, while the estimates in Section 5 extend the model to allow for the fundamental value of the firm, income and uncertainty. In Section 6 the model is simulated to provide information about the factors that have shaped investment in the US over the past two decades. Section 7 concludes.

2. The nexus between investment, credit, income, Tobin’s $q$ and uncertainty

Figure 1 depicts the four-quarter change in those variables most commonly considered as determinants of investment, in addition to willingness to lend: the investment rate, Tobin’s $q$, the profit rate (cash-flow), uncertainty and willingness to lend. The investment and real after-
tax profit rates are measured as a proportion of total capital stock. Uncertainty here reflects uncertainty in returns to investment and is measured as the standard deviation of daily S&P500 data over each quarter following Greasley and Madsen (2006). Willingness to lend is measured as one minus the fraction of responding banks that affirmed tightened standards. Credit standards are transformed to four-quarter changes in standards by summing over the past four quarters of ‘changing credit standards’. Survey data recording the willingness to lend of U.S. domestic banks and foreign bank’s agencies in the U.S. to firms for commercial and investment loans has been collected on a quarterly basis since 1990.1Q as part of the Federal Reserve Bank’s Senior Loan Officer Opinion Survey on bank lending practices (2010). The most recent survey used collected responses from 55 U.S. domestic banks and 21 U.S. branches and agencies of foreign banks. Essentially, the willingness to lend data pertains to the question of “Over the past three months, how have your bank's credit standards for approving applications for C&I loans or credit lines—other than those to be used to finance mergers and acquisitions—to large and middle-market firms and to small firms changed?” Data is available for large and medium firms and small firms separately. Large and medium firms are defined as those with annual sales of $50 million and more and small firms those with sales of less than $50 million. Data construction and data sources are detailed in the Data Appendix.

**Figure 1.** The relationship of Investment with Tobin’s $q$, Profit rate, Willingness to Lend and Uncertainty

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1 Defining $\Delta' \ln C_t$ as the change in credit standards relative to credit standards in the previous quarter, where $\Delta'$ as the one-quarter difference operator, then the four-quarter sum of changing credit standards can be written as:

$$
\Delta' \ln C_t + \Delta' \ln C_{t-1} + \Delta' \ln C_{t-2} + \Delta' \ln C_{t-3} = (\ln C_t - \ln C_{t-1}) + (\ln C_{t-1} - \ln C_{t-2}) + (\ln C_{t-2} - \ln C_{t-3}) + (\ln C_{t-3} - \ln C_{t-4}) = \ln C_t - \ln C_{t-4} = \Delta \ln C_t,
$$

where $C$ is the four quarter change in credit standards. The equation shows that the four-period sum of changing credit standards measures the change in willingness to lend relative to four quarters earlier.
Notes. The data are measured as the percentage change from the quarter one year before. The investment and profit rates are measured as the amount of investment and after tax profit as a proportion of total capital stock. The profit measurement is corporate profits after tax and is deflated by the economy-wide value-added price deflator. Willingness to lend is measured as one minus the fraction of banks reporting tightened credit standards and is estimated as a weighted average of large and small firms. Uncertainty measures the volatility of the US S&P 500 firms calculated as the standard deviation of the daily stock price index over 90 day periods. All the data are normalized to a mean of zero and a standard deviation of one for comparative purposes. See the data appendix for construction of the data and data sources.

Several observations are made in visually comparing these data. First, the two measures holding up strongest in their comparison with investment emerge as willingness to lend, followed by Tobin’s $q$. Both of these indicators explain the two major upturns and downturns in investment over the past two decades and appear to lead investment by one or two quarters. However, while willingness to lend has not given any false signals about investment in the considered period, Tobin’s $q$ has moved inversely with investment during the periods 1992-1995 and 2003-2004, suggesting that willingness to lend is a more reliable driver or predictor of investment than Tobin’s $q$. The question remains as to whether Tobin’s $q$
provides information independently of willingness to lend that can help explaining investment. This issue is addressed in the empirical section.

Second, given the prior consensus regarding the role of cash flows for investment, it is interesting to note that profits look to correlate much less with investment than willingness to lend and Tobin’s q. While investment growth is a smooth series, growth in the profit rate often gives false signals about investment as confirmed by the study of Greasley and Madsen (2006) covering a century of data. Furthermore, apart from the most recent decline, the profit rate failed to correlate with large swings in investment. Although the macro level data analysed here are not directly comparable with the firm level data used in most of the previous studies, the aggregate data does seem to reflect the ambiguity of the findings in the literature. Third, visually there is no clear correlation between investment and uncertainty, which, to some extent, reflects that the change in the variance of stock prices by nature is volatile and that uncertainty and investment go in reverse. Taking these factors into account, the figure shows that uncertainty and investment move in opposite directions giving some evidence of the uncertainty hypothesis of Dixit and Pindyck (1994).

3. Theoretical framework
This section extends the Tobin’s q model of corporate investment by Blanchard (1983) by incorporating credit constraints. In Blanchard’s (1983) model, demand is influential for non-residential investment because goods markets fail to clear. It is assumed that the cost of borrowing is set exogenously by the international credit market in a fixed exchange rate regime, or by monetary authorities under flexible exchange rates. An endogenous discount rate is not considered since it increases the complexity of the model without affecting the steady-state properties of the model nor giving additional insight into the influence of credit and demand shocks on capital stock and equity prices (see Madsen and Davis, 2006, for an extension of the model to allow for an endogenous discount rate). Taxes are omitted for simplicity.

The objective problem of the firm can be summarised as follows:

$$\max V = \int_{t=0}^{\infty} \gamma \cdot e^{-\gamma t} dt,$$  
(1)

where

$$\gamma = F(K, L) - wL - b \cdot i \cdot K - (1 - b)(1 + \phi(K / K))I + b \cdot K \cdot \pi$$  
(2)
where $b$ is the fraction of investment financed by debt; $r$ is the required returns of owners of the firm, $i$ is the nominal interest rate paid by the investor on debt finance; $I$ is investment; $K$ is the capital stock of the individual investor; $\phi$ is convex investment adjustment costs which are symmetric in investment and, as standard in the literature, is given by
\[ \phi \left( \frac{\dot{K}}{K} \right) = \alpha d^2 / 2K ; \]
$L$ is the labour used in production measured in effective labour hours; $w$ is real wages; and $\pi$ is the inflation rate. A dot over a variable signifies the absolute change over time. $F(K, L)$ is a well-behaved production function. The last term, $b \cdot K \cdot \pi$, is the inflation-induced reduction in the real value of debt.

The representative investor makes their investment decision subject to the capital accumulation constraint:

\[ K = I. \]  

(3)

Depreciation is ignored for simplicity without affecting the results. Also for simplicity, it is assumed that all investment is debt financed and therefore $b = 1$. The credit constraint can therefore be written such that investment is capped at $\bar{I}$ which is the maximum amount of credit the representative firm is able to access:

\[ I \left( 1 + \phi \left( \frac{\dot{K}}{K} \right) \right) = \bar{I}. \]  

(4)

Limitations on demand for investment output are also considered as a constraining influence for investment. A rational and forward looking investor will only invest where demand for investment output is positive, thus investment output is also constrained by the quantity of output demanded, $\bar{Q}$:

\[ \bar{Q} = F(K, L) \]  

(5)

Combining (1)-(5), the explicit adjustment cost function and the condition that all investment is debt financed yields the current-value Hamiltonian of the representative investor:

\[ \Psi_{h, I, \lambda, q, \mu} = F(K, L) - wL + (\pi - i) \cdot K - \lambda \left[ I \left( 1 + \frac{\alpha d^2}{2K} \right) - \bar{I} \right] - q(K - I) - \mu F(K, L) - \bar{Q} \]  

(6)
where $\lambda$, $q$ and $\mu$ are the shadow values, $0 \leq \lambda \leq 1$ and $0 \leq \mu \leq 1$. Here, $\lambda$ is the present value to the investor of loosening up the credit constraint by one unit, $q$ is the present value of an additional unit of capital stock and $\mu$ is the present value to the investor of loosening up the demand constraint by one unit.

The first order conditions other than those that restate the constraints and the transversality condition are as follows:

$$\frac{\partial \Psi}{\partial K} = -\dot{q} + rq \quad \Rightarrow \dot{q} = rq - \left[ F'_k(1-\mu) + (\pi - i) + \frac{\alpha d^2}{2K^2} \lambda \right], \quad (7)$$

$$\frac{\partial \Psi}{\partial l} = 0 \quad \Rightarrow q = \lambda \left(1 + \frac{3\alpha d^2}{2K}\right), \quad (8)$$

Equation (7) specifies the no arbitrage equilibrium; the investor will balance the present value of the future marginal product of capital, accounting for inflation and adjustment costs, with the required return. Condition (8) shows that the value to the investor of obtaining one unit of capital at the margin depends on the acquisition costs inclusive of the shadow cost of debt and marginal adjustment costs.

To solve for the equation specifying the dynamic behaviour of investment, equation (8) is solved for $\dot{K}$:

$$\dot{K} = \left[\frac{2K}{3\alpha} \left(\frac{q}{\lambda} - 1\right)\right]^{1/2} \quad (9)$$

Equation (9) says that any wedge developed between the value of capital to the investor and the acquisition cost of capital will drive supply side responses such that the shadow cost equals the acquisition cost of capital.

Equation (9) is the key equation in the paper. It shows that the investment ratio depends solely on Tobin’s $q$ and credit constraints. The more credit constrained are firms, the higher is $\lambda$ and the higher is the benchmark level of $q$ at which investment is undertaken. It is noticeable that demand constraints do not enter the investment decision. This is because demand constraints go through the channel of $q$. Increased demand relaxes the demand constraint and increases the value of the marginal productivity of capital (through the term $F'_k(1-\mu)$ in Eq. (7)), which in turn increases the present value of the firm and consequently $q$. The higher $q$ initiates a capital deepening process. Thus, in this framework the investment decision is independent of demand.
4. Empirics

This section tests the empirical implications of the model derived in the previous section. In the first part of this section it is tested whether Tobin’s $q$ and willingness to lend can explain corporate investment. The second part of the section tests the robustness of the results by extending the model to allow for uncertainty, default risk, credit demand, output demand, and cash-flow.

In the previous section it was shown that the investment ratio is a function of Tobin’s $q$ and credit constraints (Eq. 9). Before extending the model to allow for other control variables the following stochastic counterpart of the model is regressed:

$$\Delta \ln(I/K) = \alpha_0 + \sum_{i=1}^{3} \alpha_i C_{t-i} + \sum_{i=1}^{3} \beta_i \Delta \ln q_{t-i} + \varepsilon_t,$$

where $\Delta$ is the four-quarter difference operator, $I$ is real private non-residential fixed investment, $K$ is real private non-residential capital stock, $C$ is banks’ willingness to lend, $q$ is Tobin’s $q$ as measured by the capitalized value of the capital stock divided by the acquisition cost of capital at current costs, and $\varepsilon$ is a stochastic error term. As in Figure 1, $C$ is willingness to lend, and is measured as one minus the proportion of banks who have tightened their credit for large companies (those with annual sales of $50$ million and more), small companies (the remainder), and a weighted average of the two. Thus, we would expect the coefficient of willingness to lend to be positive.

**Table 1. Parameter estimates of Eq. (10).**

<table>
<thead>
<tr>
<th>Dependent variable $\Delta \ln \frac{I}{K_t}$</th>
<th>Average General</th>
<th>Specific</th>
<th>Big General</th>
<th>Specific</th>
<th>Small General</th>
<th>Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>0.019*</td>
<td>0.020**</td>
<td>0.018</td>
<td>0.019*</td>
<td>0.018**</td>
<td>0.021**</td>
</tr>
<tr>
<td></td>
<td>(1.845)</td>
<td>(1.992)</td>
<td>(1.595)</td>
<td>(1.744)</td>
<td>(2.051)</td>
<td>(2.274)</td>
</tr>
<tr>
<td>$\Delta C_{t-1}$</td>
<td>0.044*</td>
<td>0.083***</td>
<td>0.041**</td>
<td>0.075***</td>
<td>0.044**</td>
<td>0.057***</td>
</tr>
<tr>
<td></td>
<td>(1.913)</td>
<td>(10.35)</td>
<td>(1.955)</td>
<td>(9.592)</td>
<td>(2.027)</td>
<td>(3.262)</td>
</tr>
<tr>
<td>$\Delta C_{t-2}$</td>
<td>0.032</td>
<td>0.033</td>
<td>0.030</td>
<td>0.043**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.969)</td>
<td>(1.169)</td>
<td>(1.017)</td>
<td>(2.216)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta C_{t-3}$</td>
<td>0.014</td>
<td>-0.007</td>
<td>0.038</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.437)</td>
<td>(-0.228)</td>
<td>(1.274)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
\[ \Delta C_{t-4} \quad -0.008 \quad 0.005 \quad -0.019 \\
\quad (-0.344) \quad (0.265) \quad (-0.858) \\
\Delta \ln q_{t-1} \quad -0.003 \quad 0.009 \quad -0.011 \\
\quad (-0.081) \quad (0.270) \quad (-0.343) \\
\Delta \ln q_{t-2} \quad 0.044 \quad 0.029 \quad 0.061 \\
\quad (1.059) \quad (0.689) \quad (1.510) \\
\Delta \ln q_{t-3} \quad -0.012 \quad -0.008 \quad 0.008 \\
\quad (-0.292) \quad (-0.195) \quad (-0.200) \\
\Delta \ln q_{t-4} \quad -0.022 \quad 0.034 \quad 0.011 \\
\quad (0.588) \quad (0.863) \quad (0.302) \\
\]

Notes. The figures in parentheses are \( t \)-statistics. The \( t \)-statistics are based on the Newey-West heteroskedasticity and autocorrelation consistent covariance matrix. The coefficients of \( C \) are multiplied by 1000. \( C \) is measured as the change in willingness to lend for a weighted average of large companies (those with annual sales of $50 million and more) and small companies (the remainder) in the first two columns. The third and fourth columns are for large companies and the last two columns are willingness to lend to small companies. * = significant at the 10% level, ** = significant at the 5% level, and *** = significant at the 1% level.

The standard errors are based on the Newey-West autocorrelation and heteroskedasticity consistent covariance matrix. All the explanatory variables are lagged one to four periods to capture the dynamic adjustment of investment to its determinants. Contemporary and further lags of \( q \) and \( C \) were initially included in the regressions; however, the estimated coefficients were insignificant and consequently omitted.\(^2\) The model is estimated for the US over the period 1991.2Q-2009.1Q. Results of general and specific models are presented in the tables below, where coefficients in the specific models are restricted to zero using the general-to-specific model reduction procedure (the variable with the most insignificant coefficient is deleted in each regression round until all coefficients are significant at the 5 percent level excluding the constant term).

The results of estimating Eq. (10) are presented in Table 1. The estimated coefficient of willingness to lend is statistically highly significant in all the estimates in Table 1. The elasticity of willingness to lend is slightly higher for firms with annual sales of less than $50 million, which is not surprising given that smaller firms have been found to be more dependent on credit for external finance than larger firms (Lízal and Svejnar, 2002). The significance of \( C \) gives very strong empirical support to our hypothesis that willingness to

\(^2\) Contemporary \( q \) was instrumented using two lags of \( q \), per capita income and cash-flow. Contemporary \( C \) was instrumented using two lags of \( C \), per capita income and cash-flow.
lend is an essential factor behind investment dynamics and confirms the visual impression in Figure 1 that banks’ willingness to lend explains a large part of investment fluctuations. Further support for the credit hypothesis is given by the fact that willingness to lend precedes investment with a lead time 3-6 months. While precedence is no proof of causality, it nevertheless precludes that investment drives willingness to lend and if anything, suggests the opposite direction of influence.

Turning to the estimated coefficients of Tobin’s \( q \), these are insignificant in all general as well as specific regressions. Looking at Figure 1a this result is not surprising. Since the movements in Tobin’s \( q \) are much more erratic than the investment ratio due to the large fluctuations in the stock market, growth in Tobin’s \( q \) is unlikely to be a good predictor of growth in investment on quarterly frequencies. Using annual data there is a much stronger relationship between investment and \( q \) and willingness to lend remains a significant variable explaining investment (the results are not shown). Thus, the insignificance of \( q \) does not mean that it is an unimportant variable explaining investment; only that \( q \) does not explain quarterly-frequency changes in investment.

4.2 Allowing for the effects of income, uncertainty, default risk, cash-flow and demand for credit

To investigate the influence of other variables on investment and to test whether the significance of the willingness to lend variable is robust to the inclusion of other variables, the model is extended with variables that are often considered important for the investment decision in the investment literature. These are uncertainty, income, the interest rate spread, default risk and profits. Unrestricted and restricted versions of the following model are regressed using OLS:

\[
\Delta \ln(I/K) = \alpha_0 + \sum_{i=1}^{4} \alpha_i \Delta C_{i,t-1} + \sum_{i=1}^{4} \beta_i \Delta \ln q_{i,t-1} + \sum_{i=1}^{4} \kappa_i \Delta \ln Y_{i,t-1} + \sum_{i=1}^{4} \rho_i \Delta \ln S_{i,t-1} + \sum_{i=1}^{4} \sigma_i \Delta \ln \Pi_{i,t-1} + \sum_{i=1}^{4} \zeta_i \Delta \ln \text{Var}_{i,t-1} + \sum_{i=1}^{4} \theta_i \Delta \ln D_{i,t-1} + \epsilon_{2,i}, \quad (11)
\]

where \( Y \) is per capita real income, \( S_p \) is the interest rate spread between corporate bonds BAA and a treasury bond rate of the same term to maturity, \( \Pi \) is the profit rate, \( \text{Var} \) is uncertainty and \( D \) survey evidence on the demand for credit. The profit rate is measured as nominal after
tax profits divided by real capital stock and is deflated by the economy-wide, value-added price deflator.

Following the standard in the literature, uncertainty is calculated as the standard deviation of the daily US S&P 500 during each quarter (see for example Romer, 1990, and Greasley and Madsen, 2006). This measure is also theory consistent. Dixit and Pindyck (1994) show that investment is negatively related to uncertainty because it lowers expected returns under asymmetric adjustment costs. In conditions of heightened uncertainty it may be preferable to wait for more information than to invest immediately because it will be difficult to recoup the investment layouts of failed investment projects. Thus, there is an option value of waiting for more information, which is an increasing function of the uncertainty surrounding the present value of expected cash flow. Since the price of an option, in addition to the interest rate on a risk-free asset is determined by the variance of the asset, it follows that our measure of uncertainty is consistent with what it is supposed to measure.

The interest rate spread is included in the regressions to cater for default risks. According to Hellmann and Stiglitz (2000), default risk, reflecting uncertainty in borrower risk, can also have an important impact on investment when equity markets are imperfect and there is uncertainty about expected returns. The credit spread has often been used as a proxy for adverse selection in the credit markets under the assumption that an increase in the spread reflects heightened risk of lending out to the most risky borrowers and, consequently, leads to adverse selection (see for instance Bernanke, 1983, and Mishkin, 1990).

Income is included in the regressions following the accelerator principle in which investment is determined by demand forces. There is no strong rationale as to why income should be a determinant of investment; however, in his survey of the literature Chirinko (1993) concludes that income is a very robust determinant of investment. It is not clear whether income determines investment of demand constrained firms, proxies cash-flow of the cash-constrained firm, proxies the expected returns to investment, or that firms invest to optimize its turnover or a combination of them. Since most of these arguments are contained in Eq. (10) the estimates below will reveal whether income contains independent information on investment that is not accounted for by \( q \), credit, cash-flow, and expected returns.

Cash-flow, as discussed in the Introduction, is often considered important for the investment decision as it is assumed to proxy the credit constrains of firms or because it reflects the fundamental value of firms as argued by Blanchard, Rhee and Summers (1993). If the discount rate is expected to remain constant into the future and if the current profit rate
reflects expected profits, the fundamental value of a share is dictated by the profit rate. The fundamental value of firms is more relevant than Tobin’s $q$ in the investment decision if firms act in the interest of the future stockholders and if stock prices are disjointed from their fundamental value.

As a final check on the model it is investigated as to the extent to which the quantity of credit is driven by the demand, as opposed to the supply, of credit. Jaffee and Modigliani (1969), for example, stressed that simple proxies of the availability of credit such as the credit volume and cash-flow are influenced by the demand as well as supply for credit and, as such, fail to identify the source of variations in the credit flow. To test for the importance of credit demand, data pertaining to reported investment demand for Commercial and Investment Loans in the Federal Reserve Bank’s Senior Loan Officer Opinion Survey on bank lending practices (20) are used. The question asked in the survey is “Apart from normal seasonal variation, how has demand for C&I loans changed over the past three months?” The average percentage of firms reporting stronger demand is used as the variable for the empirical estimations.

4.2.1 Estimates of the general model
Unrestricted and restricted estimates of Eq. (11) are displayed in Table 2. Willingness to lend is measured as the weighted average of small and large firms since the results are not very sensitive to whether $C$ is measured for small, large or the average. Considering first the unrestricted model, the estimated coefficients of willingness to lend, $q$, uncertainty, profit rates and income are statistically significant determinants of investment. Excepting profit rates, these variables remain significant in the specific model, although the higher order lags of $q$ lose their significance during the model reduction. More specifically, the estimated coefficients of variables $C_{t-1}$, $q_{t-1}$, $Y_{t-1}$, $Var_{t-2}$, $Var_{t-4}$, are significant at the five or one-percentage significance levels in the specific model. The significance of income confirms the conclusion of Chrinko (1993) that income remains an important determinant of investment, even if other relevant determinants of investment are included in the regressions. This could indicate that firms are demand constrained because they do not adjust prices sufficiently in response to demand fluctuations or that the firm has objectives other than profit maximization.

The coefficients of the interest spread and cash flow variables are all insignificant. The unimportance of the interest rate spread and cash-flow is remarkable because they are
often found to be significant determinants of investment in the microeconomic literature as discussed in the Introduction. This result may be related to Romer’s (2006) critique of microeconomic studies that cash-flow often proxies the performance of management, cost efficiencies, and the general success of the firm and that cash-flow may not be related to the availability of credit at all. In fact, the results are consistent with the macroeconomic study of Greasley and Madsen (2006) on US investment over the past century. This ambiguity also provides support for the hypothesis that the marginal productivity of cash flows differs across firms and time (Bacchetta and Caminal, 2000, Carlstrom and Fuerst, 1997).

Table 2. General to specific estimations using all variables

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>General</th>
<th>Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \ln \frac{Y}{K}$</td>
<td>0.021**</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(2.277)</td>
<td>(0.591)</td>
</tr>
<tr>
<td>$\Delta C_{t-1}$</td>
<td>-0.036</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.285)</td>
<td></td>
</tr>
<tr>
<td>$\Delta C_{t-2}$</td>
<td>0.107**</td>
<td>0.040***</td>
</tr>
<tr>
<td></td>
<td>(2.547)</td>
<td>(5.557)</td>
</tr>
<tr>
<td>$\Delta C_{t-3}$</td>
<td>-0.012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-0.284)</td>
<td></td>
</tr>
<tr>
<td>$\Delta C_{t-4}$</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.131)</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln q_{t-1}$</td>
<td>0.123**</td>
<td>0.055**</td>
</tr>
<tr>
<td></td>
<td>(2.605)</td>
<td>(2.023)</td>
</tr>
<tr>
<td>$\Delta \ln q_{t-2}$</td>
<td>-0.021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-0.332)</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln q_{t-3}$</td>
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</tr>
<tr>
<td></td>
<td>(-1.970)</td>
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<tr>
<td>$\Delta \ln q_{t-4}$</td>
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</tr>
<tr>
<td></td>
<td>(3.512)</td>
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</tr>
<tr>
<td>$\Delta \ln Y_{t-1}$</td>
<td>1.308**</td>
<td>1.930***</td>
</tr>
<tr>
<td></td>
<td>(2.801)</td>
<td>(7.132)</td>
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<tr>
<td>$\Delta \ln Y_{t-2}$</td>
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</tr>
<tr>
<td></td>
<td>(1.628)</td>
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</tr>
<tr>
<td>$\Delta \ln Y_{t-3}$</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(0.084)</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln Y_{t-4}$</td>
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<tr>
<td></td>
<td>(0.084)</td>
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</tr>
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<td>$\Delta Var_{t-1}$</td>
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<td></td>
<td>(-0.340)</td>
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<tr>
<td>$\Delta Var_{t-2}$</td>
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<td>-0.001***</td>
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<td>(-3.128)</td>
<td>(-4.534)</td>
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<td>-0.000***</td>
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<td>(-3.404)</td>
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<td>(-1.014)</td>
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<tr>
<td>$\Delta Sp_{t-2}$</td>
<td>-0.004</td>
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<tr>
<td></td>
<td>(-0.843)</td>
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</tr>
</tbody>
</table>
\[
\begin{array}{lcccc}
\Delta S p_t & -0.001 & (-0.270) \\
\Delta S p_{t+1} & -0.006 & (-1.075) \\
\Delta \ln \Pi_{t,1} & -0.068** & (-2.247) \\
\Delta \ln \Pi_{t,2} & 0.085** & (2.337) \\
\Delta \ln \Pi_{t,3} & -0.043 & (-1.152) \\
\Delta \ln \Pi_{t,4} & -0.039 & (-1.395) \\
\Delta D_{t,1} & -0.000** & (-2.192) \\
\Delta D_{t,2} & 0.000 & (0.795) \\
\Delta D_{t,3} & 0.000 & (0.652) \\
\Delta D_{t,4} & -0.000** & (-2.044) \\
\hline
R^2 & 0.908 & 0.902 \\
\end{array}
\]

**Notes.** See notes to Table 1. Willingness to lend is measured as a weighted average of small and large firms.

In conjunction with the significance of \( C \), the insignificance of the interest spread suggests that credit providers do not, or cannot, differentiate between the qualities of different categories borrowers by charging higher interest rates on risky loans as proposed by Bernanke (1983). Instead there are ebbs and flows in the availability of credit and risky as well as good borrowers will be affected by banks’ willingness to lend. The global financial crisis and the lead up to it certainly confirms this mechanism. It appears that good and bad housing borrowers could obtain credit during the upturn while it has recently become difficult for most borrowers to obtain credit (Federal Reserve Bank, 2010).

Finally, the credit demand variables are insignificant in the specific models. This infers that the flow of credit to firms that is important for capital accumulation is determined by banks willingness to lend rather than by demand for credit; supply constraints dominate the credit-investment relationship. This is a very important result because it shows that credit aggregates are driven by supply of credit and, more importantly, that policy initiatives to stimulate the flow of credit is downturns and discourage the flow of credit in upturns can be effectively regulated by quantity and price controls on the supply side.

5. **Simulations**

While the results in the previous section show that willingness to lend, Tobin’s \( q \), income and uncertainty are statistically significant short-term determinants of investment, their economic
significance in explaining the growth cycles has not been shown. To that end the coefficient estimates of the specific model in Table 2 are used to simulate the contribution of each of the explanatory variables to investment growth since 1991.

First, however, consider predicted versus the actual investment growth over the estimation period. The model predicts investment remarkably well. It predicts all turning points, explains ups and downs and even relatively small changes in the investment growth rate. This is strong evidence in favour of the estimated model.

![Figure 2. Actual and Predicted Growth in Investment](image)

**Notes:** The predictions are from the specific model reported in Table 2.

The model simulations are also presented numerically in Table 3. Willingness to lend and income growth explain most of the movements in investment growth closely followed by uncertainty. Tobin’s $q$ explains only a small part of investment growth. Considering the three downturns in investment growth (1991.1Q-1991.4Q, 2000.4Q-2003.3Q, and 2007.4Q-present), willingness to lend has been the most important determinant of the downturn followed by income growth and uncertainty. This suggests that credit crunches play important roles during investment downturns.

<table>
<thead>
<tr>
<th>Year</th>
<th>$C$</th>
<th>$Y$</th>
<th>$VAR$</th>
<th>$q$</th>
<th>Predicted</th>
<th>Actual</th>
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<td>-11.00</td>
<td>-8.32</td>
</tr>
<tr>
<td>Year</td>
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<td>Q4</td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
</tr>
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<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
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</tr>
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</table>
The evidence of very easy monetary policy up to the recent global financial crisis, as well as before and during the 2001-2002 recession, suggests that credit crunches need not be triggered by monetary policies but something completely different that may be endogenous to the banking system. Whether this reflects falling asset prices, falling liquidity and access to short-term funding, or changes in bankers’ expectations is left for future research. What is important here is that the simulations show that willingness to lend explains investment downturns quite independently of the stance of monetary policy.

Turning to upturns, willingness to lend and income have been the prime movers of the investment upturns. During the 1992-93 upturn, willingness to lend contributed a 6 percentage point turnaround in investment growth and income contributed about 5 percentage points. During the upturn in the period 2002.1Q to 2004.3Q willingness to lend contributed to more than an 8 percentage point turnaround in investment growth and income contributed to more than a 4 percentage point change in income growth rates.
6. Discussion and conclusion

This is the first study to investigate the credit-investment nexus using a direct measure of credit availability while allowing for the influence on investment of Tobin’s $q$, uncertainty, income, cash-flow, default risk and the demand for credit. Earlier studies stressing the importance of credit as a source of investment fluctuations use interest spreads between different risk classes of bonds, cash-flow and bank suspensions as proxies for adverse selection. Bernanke (1983), for example, argues that adverse selection was a main factor behind the investment collapse during the Great Depression using the interest rate spread between Baa Corporate bonds and long term U.S. Government bonds. The trouble with these proxies is that they proxy sources of investment fluctuations other than credit standards such as the fundamental value of shares and default risk. Survey evidence of bank’s willingness to lend overcomes the problems associated with the use of credit proxies.

The estimates showed that willingness to lend, Tobin’s $q$, income and uncertainty are all statistically significant drivers of investment. Model simulations were additionally undertaken to gauge the economic significance of these variables in explaining investment fluctuations over the past two decades in the US. Movements in banks’ willingness to lend have explained the bulk of the investment growth cycles over the past two decades followed by income, uncertainty and Tobin’s $q$. As stressed in the text, the relatively low significance of Tobin’s $q$ in explaining investment is no indication of unimportance but rather that erratic stock market fluctuations render it less useful for explaining investment growth on quarterly frequencies. Finally, neither the interest rate spread nor cash flow have any statistically significant impact on investment growth suggesting that the fundamental value of stock and default risks, if correctly captured by their proxies, are not of significance in the investment decision.

The significance of willingness to lend in the regressions and simulations has important macroeconomic implications. First, that the availability of credit is an important driver of investment on business cycle frequencies. Second, the cost of funding as reflected in Tobin’s $q$ is of minor importance for short-term movements in investment. Thus, monetary policies that influence the quantity and the availability of credit are substantially more effective in the investment decision than monetary policies that seek to influence corporate investment through interest rates policies. This result makes intuitive sense since an interest rate of three of five percent does not make much difference for an investment project with
large uncertainties in returns. Furthermore, the empirical results suggest that the macroeconomic literature could benefit from focusing more on the banking sector in explaining macroeconomic fluctuations. The banking sector is absent from most, if not all, general equilibrium models of income determination and simpler expositions and, as such, do not play a role in business cycle models. Third, heightened uncertainty, as reflected in stock price gyrations, are often associated with collapses in business investment. This was witnessed during the recession surrounding the collapse of the dotcom bubble and 911. From a historical perspective, the stock price fluctuations during the Great Depression were several times greater than the fluctuations experienced in the downturns during the past two decades. While Greasley and Madsen (2006) showed that uncertainty played a major role during the Great Depression, the importance of credit constraints during that period remains unknown.

Data appendix

Tobin’s $q$
Quarterly measures of Tobin’s $q$ were derived from Stephen Wright’s $q$ data calculated from the cyclically adjusted Price-to-Equity ratio (CAPE) (see http://www.smithers.co.uk). This data is available at monthly frequencies until December 2006 and were converted to quarterly figures by taking the quarterly averages. The data was updated until 2009.1Q using S&P500 deflated by consumer prices.

Willingness to lend
Sourced from the Federal Reserve Bank’s quarterly survey, the Senior Loan Officer Opinion Survey on bank lending practices (Federal Reserve Bank, 2008).

Small/Large firm weightings
The U.S. Census Bureau publishes statistics regarding firm size that can be found on the website http://www.census.gov/epcd/www/smallbus.html. The table detailing receipt size of employer firms was used to calculate the small-large firm weightings for the weighted willingness to lend regression.

Investment
Annual rates of real private non-residential fixed investment (seasonally adjusted) were obtained at quarterly intervals from the Federal Reserve Bank of St. Louis’s Economic Data base (FRED) at http://research.stlouisfed.org/fred2/.

Capital stock
The perpetual inventory method with a 8% depreciation rate was used to calculate non-residential capital stock. Annual rates of Real Private Non-residential Fixed Investment (seasonally adjusted) were used in the calculations (obtained at quarterly intervals over the period1947:1Q-2009.1Q from the Federal Reserve Bank of St. Louis’s Economic Data base (FRED) at http://research.stlouisfed.org/fred2/.

Variance
The variance of equity prices is calculated as the standard deviation of daily S&P500 data within each quarter. The S&P500 data is obtained from http://finance.yahoo.com/q/hp?s=%5EGSPC&a=00&b=3&c=1950&d=03&e=30&f=2009&g=d

Profit
Profit data was obtained on a quarterly basis from the Federal Reserve Bank of St. Louis’s Economic Data base (FRED) at http://research.stlouisfed.org/fred2/. The profit measurement used was “Corporate Profits After Tax (Billions of Dollars) Seasonally Adjusted Annualized” deflated by the value-added price deflator.

Income
Income was taken as real income per capita. This measure is the seasonally adjusted annual rate of real Gross Domestic Product divided by total population. All original data was obtained at quarterly frequencies from the Federal Reserve Bank of St. Louis’s Economic Data base (FRED) at http://research.stlouisfed.org/fred2/.

References


