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Does monetary policy have asymmetric effects? A look at the investment decisions of Italian firms

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DOES MONETARY POLICY HAVE ASYMMETRIC EFFECTS? A LOOK AT THE INVESTMENT DECISIONS OF ITALIAN FIRMS

by Eugenio Gaiotti[*] and Andrea Generale[*]

Abstract

This paper studies the effects of monetary policy on the investment behaviour of various categories of Italian firms, using a panel from the Company Accounts Data Service (*Centrale dei Bilanci*). The exercise aims to shed light on the quantitative importance of a channel of transmission operating through balance sheets. Financial variables matter (when defined as either cash flow or the stock of liquidity); small firms and firms which have a larger share of assets that cannot be used as collateral are more affected by monetary policy. In quantitative terms, the difference in the response of investment by different types of firms turns out not to be negligible; however, the implications of this finding for transmission asymmetries across euro-area countries should not be overemphasized. Our main policy conclusion is that monitoring the financial conditions of different types of firms is important in order to assess the overall monetary stance.

JEL classification: E22, E50.

Keywords: investment, monetary transmission, user cost of capital.

Contents

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1. Introduction[1]

How does monetary policy affect the investment decisions of Italian firms? Does its effect vary according to firms' characteristics? The question is not new, but up to now it has been only indirectly addressed using micro data. This paper presents a first set of results obtained from a panel of Italian firms. The exercise aims to shed light on the possible existence and on the quantitative importance of effects of monetary policy through firms' balance sheets, as well as on asymmetries in policy transmission. The results may have implications for euro-area monetary policy.

In the debate on the features of monetary policy transmission in the euro area, a common claim is that recourse to micro data is necessary since the macro evidence is ambiguous. The claim has been advanced, among others, by Guiso *et al.* (2000). It is commonly believed that the use of micro data presents two advantages. First, exploiting cross-sectional variability may help to overcome the identification problems that affect the estimation of monetary policy effects at the macro level. For instance, exogenous cross-sectional variations in taxation may help estimating the response of investment to changes in the price of capital (Cummins, Hassett and Hubbard, 1994). Second, the existing structural differences among the euro-area countries (the size of firms, the size and number of banks, the degree of bank dependence, the features of the financial system) are usually regarded as the main argument for the existence of transmission asymmetries (Kashyap and Stein, 1997; Dornbusch, Giavazzi and Favero, 1998; Favero and Giavazzi, 1999). In this respect, it is important to test empirically which types of microeconomic heterogeneity are important at the country level.

Among the factors that may determine differences in monetary transmission are those

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linked to the "broad credit channel" view of monetary transmission. According to this view, owing to information asymmetries, "opaque" firms face a higher cost of external finance and are subject to liquidity constraints. The model developed by Bernanke, Gertler and Gilchrist (1996) shows that the direct effects of a change in the interest rate are transmitted not only through the resulting increase in the user cost of capital (the neoclassical channel of transmission), but also through the exacerbation of financial constraints: an increase in policy rates is reflected in larger interest payments, hence a worsening of the firm's cash flow, and in a decrease in the value of assets that could be used as collateral for new loans. Furthermore, the macroeconomic impact of monetary policy on sales can affect investment decisions both directly (as sales enter the neoclassical demand for capital) and through their effect on the cash flow. Several characteristics of firms that differ across countries in the euro area have been assumed *a priori* to affect the potency of monetary policy by tightening the financial constraints: size, level of indebtedness, maturity structure of debt, availability of collateral.

The possible existence of "broad credit channel" effects may thus be relevant to euro-area policymakers in two respects. In an extreme case, the differences in firms' characteristics across countries may determine systematic asymmetries in policy transmission so large that the area-wide policymaker cannot realistically ignore them. Favero and Giavazzi (1999) stress that, while the regional impact is usually not at the centre of the monetary policy debate, an uneven distribution of the effects of monetary policy may make the management of a single monetary policy more difficult, since countries are largely the frame of reference in EMU. More generally, if monetary policy is found to be transmitted through changes in balance sheets and in internal finance, the euro-area policymaker would be well advised to keep a close watch on the financial conditions of firms in the area, both at the aggregate and disaggregate level.

Against this background, a number of issues are relevant to identifying the dimensions in which "broad credit channel" effects and transmission asymmetries may arise. Is the change in the user cost of capital the main determinant of investment (does the neoclassical model hold?), and, if so, is the elasticity different across types of firms? Are financial variables relevant and, again, do they affect different firms in different ways? Are other factors at work, e. g. through the effect of monetary policy on the demand for the firm's output, which may also contribute to generating transmission asymmetries across sectors of the economy?

2. Monetary policy and investment decisions in Italy: the existing evidence

The existing evidence on the link between monetary policy and investment decisions in Italy was mainly obtained at the macroeconomic level. The quarterly model of the Italian economy (Banca d'Italia, 1986) features a demand for capital based on a standard CES production function; the demand for capital is affected by its user cost, which in turn depends on the interest rate. In Banca d'Italia (1986), the elasticity of substitution between capital and labour was estimated to be 0.9; in later versions of the model, it was constrained to be equal to one, assuming a Cobb-Douglas production function. Taking into account all the interactions in the model, a one percentage point increase in the interest rate has a negative impact on non residential investment of the order of 2-3 percentage points each year (for about six years: Nicoletti Altimari *et al.*, 1995). Other studies conducted at the macro level also rely on the assumption of a Cobb-Douglas production function (e. g. Parigi and Siviero, 2000).

At firm level, the Italian literature, following the international mainstream, focuses on the effect of financial constraints on investment behaviour; the role of financial constraints in the investment function is investigated to spot the existence of information asymmetries and the working of a "broad" credit channel. Surveys of the international debate and of the methodological issues are in Chirinko (1993) and Hubbard (1998). Different dynamic specifications of the investment function (accelerator specification, formulation based on Tobin's Q, Euler equation)[2] have been estimated, testing whether financial constraints significantly enter the equation and whether they differently affect groups of firms with particular characteristics related to the existence of information asymmetries. For Italy, a common finding is that financial variables affect investment for particular groups of firms. Galeotti, Schiantarelli and Jaramillo (1991), using a Q model on a sample from the Company Accounts Data Service *(Centrale dei Bilanci)*, find that cash flow is a determinant of

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[2] A brief discussion of the various specifications is in section 4.

investment for small firms but not for large ones. Schiantarelli and Sembenelli (2000) estimate an accelerator model and find that firms belonging to large and medium-sized business groups are less sensitive to the availability of cash flow, confirming the crucial role that internal finance plays for solo firms. Bianco (1997) estimates a Euler equation and finds that Italian firms' investment decisions are affected by the availability of internal funds, measured by the cash flow; the effect is stronger for small firms. She also finds that firms that have a stable relationship with a bank are less responsive to financial constraints. More recently, Bagliano and Sembenelli (2001) study the effects of the recession of the early 1990s on inventory investment, using micro data from Italian, French and British firms. They find a strongly pro-cyclical behaviour of inventories and a significant effect of financial factors (leverage) on inventory behaviour; they also find that for small and young Italian firms the leverage effect on inventories is larger.

These results only give an indirect, and mostly qualitative, hint of monetary policy's impact on different classes of firms. For a more precise assessment of that impact, two alternative directions can be pursued. The effect of the user cost of capital, which depends on interest rates, can be explicitly included in the estimated investment functions based on panel data. Alternatively, the effect of monetary policy measures on the activity of different size classes of firms can be directly estimated using time-series methods; however, this is only possible when long time series for classes of firms are available, which is not always the case.

Including the user cost in investment equations. In most empirical work based on panel data, the user cost of capital is not included in investment functions. It is assumed to be the same for all firms (it is a transformation of the interest rate), and its effect is accounted for by the time dummies. While this approach makes it possible to obtain a consistent estimation of the remaining parameters, it sheds no light on the effect of monetary policy. Chirinko, Fazzari and Meyer (1999) construct a firm-specific measure of the user cost of capital. While still using a single interest rate for all industries and assets in their sample, they differentiate across firms using information on asset-specific purchase prices, output prices for every industry, investment tax credit and depreciation allowances for each asset, and asset-specific depreciation rates. They find elasticity to the user cost of the order of -0.25, much smaller than would be implied by a Cobb-Douglas production function.

Alternatively, Ber, Blass and Yosha (2000), in order to estimate directly the effect of monetary policy on firm-level investment, proxy the user cost of capital with the short-term rate and omit time dummies from the regression. However, this approach can result in biased estimates and is particularly problematic if the time dimension of the sample is limited. For Italy, we are aware of no company-level estimates of the elasticity of investment to the user cost of capital.

Directly estimating the effect of monetary policy on classes of firms. The effect of monetary transmission was also addressed using time-series data for different size classes of firms. In order to follow this approach, the time series should be of a reasonable length. For the US, Gertler and Gilchrist (1994) use quarterly data from the *Quarterly Financial Report for Manufacturing Corporations*, available for different size classes. For Italy, Rondi *et al.* (1998) use annual data for a closed sample of private companies collected by Mediobanca from 1968 to 1991. They define episodes of monetary tightness using a qualitative dummy, regress various balance sheet items on the policy indicator and also estimate investment and sales equations for groups of firms, including the short-term interest rate among the explanatory variables. They find that, following a tightening, small firms report a steeper fall in sales and inventory. They also find that fixed investment decisions by small firms are more sensitive to measures of creditworthiness in periods of monetary tightening. However, they do not find a significant role for the interest rate in a fixed investment equation based on time-series data for the different size classes of firms.

Other approaches are based on a combination of micro and macro evidence or on descriptive analysis. Dedola and Lippi (2000) estimate the effects of monetary policy on different industrial sectors of five countries by means of a VAR, then explain the cross-industry differences in terms of characteristics of each sector derived form micro data. They find a significant role for output durability, investment intensity and measures of firms' borrowing capacity (size and interest burden). Guiso *et al.* (2000) discuss in a descriptive way the importance of several characteristics in explaining the Italian firms' response to the 1992 monetary tightening and the 1993 recession. They find that size and export orientation matter in this respect.

Our analysis of a sample of Italian firms aims at filling some of the gaps in the existing literature. We ask the following questions.[3]

How large is the response of investment to the user cost of capital, and is it different across groups of firms? As mentioned, not much evidence on this issue is now available for Italy. We try to answer by constructing firm-specific measures of the user cost for our panel. In principle, differences in user cost elasticity should only reflect technology and substitution possibilities. In practice, however, the estimate is likely to capture other monetary policy effects not adequately controlled by the introduction of other variables (e. g. credit rationing and financing constraints not completely captured by the inclusion of financial variables in the regressions). If the neoclassical model of investment does not work for firms facing financial constraints, this will show up in particular variables entering the regression (financial variables, interest rate spreads: see, for instance, the discussion in Gertler, Hubbard and Kashyap 1991); however, such a finding could be reinforced by the existence of differences in the estimated effects of the user cost across firms with certain characteristics. The groups of firms that we analyse (discussed in detail in section 6) are those for which different effects of monetary policy can be expected, on the basis of credit channel effects.

Does the cash flow affect investment decisions, and is this effect different across groups of firms? A significant effect of financial variables for "opaque" firms may reflect the working of a "credit channel". A significant cash flow coefficient is not sufficient in itself to prove the presence of financial constraints (it may be a measure of profit expectations); however, differences in cash flow coefficients across particular groups may be more easily interpreted in that way.[4] As mentioned, for Italy there is already a reasonable body of evidence, suggesting that financial constraints do matter for some categories of firms. However, a joint estimation of the effects of the cash flow and of the user cost has not been performed. Chirinko, Fazzari and Meyer (1999) show that interactions between the two

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[3] Rosolia and Torrini (2001) have followed a parallel and complementary line of research, estimating investment equations for large and small manufacturing firms, using the same database we use. They do not focus on the issue of the effects of monetary policy; however, they reach results on the link between investment decisions and financial conditions quite consistent with ours.

[4] Using the cash stock, instead of cash flow, as a measure of financial constraints can supply a further

variables can affect the estimates. Since the cash flow and the firm-specific user cost are correlated by construction (see the Appendix), in order to reach robust conclusions it is important to include a measure of the user cost in the regression.

How does monetary policy affect the user cost, the cash flow and sales (the main explanatory variables in investment equations) and are there quantitatively significant differences in these effects across groups of firms? This issue is virtually unexplored. Yet, an answer is essential to a full understanding of the effects of monetary policy, as this is obviously the first link of the transmission process. Moreover, although we do not directly tackle this issue, this could also be a possible source of asymmetries. For instance, close bank-customer relationships may smooth the effect of changes in policy rates on the cost of credit for some categories of firms, thereby attenuating the impact of monetary policy on investment irrespective of the user-cost elasticity of investment. It has been argued that this may be particularly important for small firms and small banks in Italy.[5] The same argument applies to the effect of monetary policy on cash flow. In turn, sales are an important determinant of investment, and they are affected by monetary policy in a way that may depend on the interest-sensitivity of the demand for the firm's output. Fazzari (1993) goes so far as to argue that, for the US, too much emphasis is usually placed on the cost-of-capital channel of transmission of policy to investment, and that greater weight should be placed instead on changes in the level of economic activity and on the financial conditions of the corporate sector.

From a methodological standpoint, our analysis is in two steps. First, we estimate the elasticity to the user cost and to financial variables obtained from an investment function, both for the whole sample and for groups of firms that are assumed to be more "opaque", hence more subject to financial constraints (section 6). Second (section 7), we exploit some macroeconomic relations obtained from the quarterly model of the Italian economy to evaluate the effect of monetary policy on the main determinants of investment demand (the user cost, the cash flow, sales) and consequently on different types of firms. This allows us

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robustness check (see sections 4 and 6).

[5] Some evidence on a weaker "bank lending channel" for small banks owing to customer relationship in Italy is provided by Angeloni *et al*. (1995).

to assess the relative importance of various transmission channels, as well as the quantitative importance of asymmetric effects, both domestically and in an international comparison.

Before turning to the econometrics, the main stylized facts on the reaction of different groups of firms to monetary restriction are set out in section 3, the main specifications for investment functions used in the literature reviewed in section 4, and the features of the dataset we employ discussed in section 5.

3. Italian firms' investment, cash flow and monetary episodes: some stylized facts

Guiso *et al.* (2000) conduct a descriptive analysis of the behaviour of Italian firms during the 1992-93 recession. As they note, the limit of a descriptive approach is that it is hard to disentangle monetary shocks from real shocks; it is also difficult to control for different factors affecting the reaction of groups of firms to the business cycle. Nonetheless, the stylized facts in episodes of monetary restriction are a useful reference for the econometric analysis.

Tables 1 and 2 present the main balance sheet items for the sample of non-financial firms included in the Italian Company Accounts Data Service (*Centrale dei Bilanci*) (see Appendix), whose database contains information on the profit and loss account and balance sheet for some 35,000 non-financial firms from 1982 to 1999, for a total of 590,000 observations. In the tables, we distinguish firms according to size (small and large) and sector (manufacturing, services and commerce).

The sample shows a substantial heterogeneity among firms of different sizes. According to the descriptive statistics, size seems to affect the exposure to financial constraints, as small firms are more leveraged, more dependent on banks and on short-term debt, and have a smaller cash flow and heavier interest burden. Table 2 shows average statistics for the years 1997-98. For small firms, leverage was 57 per cent in the manufacturing sector and 62 per cent in services and commerce. Bank loans were around 25 per cent of total liabilities, as opposed to between 14 and 19 per cent for large firms; the proportion of short-term debt was also higher (74 per cent of total bank debt, compared with about 50 per cent for large firms). Debt securities, which made up less than 2 per cent of total liabilities for the sample as a whole, accounted for less than 1 per cent for small firms.

Higher levels of leverage impact on interest expense: in 1997-98 these were 2.8 per cent of total assets for small firms, 2.3 per cent for larger manufacturing firms, 2.0 per cent for larger commercial and services firms. Cash flow was also lower for small firms, and in particular, for those operating in the services sector. Gross investment as a percentage of total assets was lower for small firms; however, in the manufacturing sector this gap tended to close in recent years.

An anecdotal look at the main episodes of monetary restriction in the last two decades indicates some regularities: after a tightening, cash flow and investment decreased, although with varying lags; the decrease was usually more pronounced for small firms.

In the period 1982-1999 the Italian economy experienced *three recessions* (the end of the 1980-82 episode, 1992-93 and 1996)[6] and *three main episodes of monetary restriction* (1986-87, 1992 and 1994-95).[7]

The 1986-87 monetary restriction was aimed at countering tensions in the foreign exchange market. Despite a temporary tightening of liquidity conditions and a rise in very short-term rates, however, bank lending rates continued to come down through most of 1987, reflecting the fall in inflation, the continued effect of the lifting of credit controls in the early 1980s and increased competition in the banking market. The downward trend of nominal rates halted, and was partly reversed, at the end of 1987. The upward trend of the cash flow/assets ratio and of the investment/assets ratio came to a halt at the same time (Figure 1). In 1989, monetary policy was again temporarily tightened and the average lending rate started to rise. In the following two years, investment and cash flow fell as a percentage of total assets.

The contraction in the investment/assets ratio was initially stronger for smaller firms (Table 3 and Figure 2). In particular, in 1989 the increase in interest rates hit firms characterised by a higher ratio of short-term debt to total assets (i. e. mainly small

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[6] The precise chronology of recession periods proposed by Altissimo, Marchetti and Oneto (2000) is 1980:3-1983:3, 1992:3-1993:7, 1995:11-1996:11.

[7] See Gaiotti (1999). The major restriction at the beginning of the 1980s is not included because it mostly falls outside our sample. There were also other instances of monetary tightening in the 1980s, notably in 1989; these are, however, less straightforward to interpret, often representing only a temporary reaction to the

companies), causing a contraction in cash flow and investment, whereas for larger firms investment expanded in relation to total assets in 1989. In 1990-91, investment fell for every category of firm.

The *monetary restriction of 1992* was particularly severe, aimed at countering the turbulence in the European Monetary System and, after the devaluation of the lira in September, the threat of imported inflation. The repo rate (the Bank of Italy's main policy rate) rose by an average of more than 2 percentage points with respect to 1991, with an increase of more than 6 percentage points at peak; the average lending rate increased by 1.7 percentage points year on year. The decrease in the cash flow/assets ratio was particularly severe during the recession, as firms' interest expense went up to 5 per cent of total assets (from 4.3 per cent in 1990-91), absorbing 30 per cent of gross income. Gross investment declined. The investment/asset ratio remained low in the subsequent 1994-95 expansion.

In 1992-93, the cash flow/assets ratio of small firms in services and commerce (which had been characterized by higher operating profits and lower leverage) deteriorated much more than did that of large firms in the same sectors (Table 3). On the whole, the contraction in the investment/asset ratio was less pronounced for large manufacturing firms than for firms operating in services and commerce, probably owing to the asymmetric effects of the currency devaluation.[8]

The reduction in interest rates beginning in mid-1993 contributed to a marked decrease in interest expense and to an increase in the cash flow/assets ratio;[9] the latter rose of more than 1.5 percentage points between 1993 and 1994.

Monetary policy tightened again in 1995, and the growth in the cash flow ratio declined and then turned negative during the 1996 recession. In 1996 the investment/assets ratio for the whole sample kept growing: the effect of the recession was partly offset by monetary easing beginning in 1996 and by the ensuing reduction in interest expense.

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dynamics of the exchange rate or money growth.

[8] Guiso *et al*. (2000) note that "due to the combination of the sharp devaluation (which greatly benefited export-oriented firms) and the tight fiscal policy (which heavily affected firms with a domestic market), the recession and the subsequent recovery were unevenly distributed."

[9] A contribution also came from the decrease in leverage brought about by the low level of investment.

In 1996 investment over total assets generally fell for small manufacturing firms, while cash flow over total assets also contracted for large firms. For large manufacturing firms, the effects of the monetary restriction may have again been counterbalanced by the sharp weakening of the exchange rate.

4. The specification

A large body of theoretical and empirical literature analyzes the determinants of investment. Virtually all empirical models obtain the optimal capital/output ratio from the solution of the firms' profit maximization problem, yielding a desired capital stock positively related to output and negatively to the user cost of capital; the latter is the cost incurred by using capital, due to interest expense, depreciation, price level changes and fiscal factors (a standard definition is in the Appendix).

(1) $$k_{i,t} = a_0 y_{i,t} + a_1 uc_{i,t}$$

where $k_{i,t}$ is (the log of) the capital stock, $y_{i,t}$ can be (the log of) either sales or output and $uc_{i,t}$ is a measure of (the log of) the user cost of capital.

Dynamics are then added in different ways (either "implicitly" or "explicitly", by modifying the optimization problem: Chirinko, 1993). Bond *et al.* (1997) review the most common empirical specifications: the accelerator, the error correction model and the Euler equation.[10] In this paper we will concentrate on the "implicit dynamics" specifications, i. e. the accelerator and the error correction models. The accelerator specification has the form:

(2) $$\frac{I_{it}}{K_{i,t-1}} = b_0 \frac{I_{i,t-1}}{K_{i,t-2}} + \sum_{j=0}^{n} g_j \Delta y_{i,t-j} + \sum_{j=0}^{n} j_j \Delta uc_{i,t-j} + d_t + h_i + v_{it}$$

where i stands for the firm , t is a time index, $I_{i,t}/K_{i,t-1}$ is investment over the capital stock, d_t is a time-specific effect, h_i is a firm-specific effect. Equation (1) can be derived from the equilibrium condition for the desired capital stock, assuming that investment is a distributed

[10] They do not consider the Q model of investment (see Chirinko, 1993), which is also widely used in empirical work as it is usually implemented for listed companies. It can be used for unlisted firms only if the

lag of the change in the desired capital stock, considering that $I_{i,t}/K_{i,t-1} \cong \Delta k_{i,t} + d_i$, where d_i is the depreciation rate.

The error correction model can be obtained from the same equation for the desired capital stock, assuming a partial adjustment mechanism. As pointed out by Bond *et al.* (1997), it allows information on the levels of output and the capital stock to be retained, thus ensuring convergence of the current stock of capital to a long run value. The model is:

$$(3) \qquad \frac{I_{it}}{K_{i,t-1}} = b_0 \frac{I_{i,t-1}}{K_{i,t-2}} + J_0(k_{i,t-2} - J_1 y_{i,t-2}) + \sum_{j=0}^{n} g_j \Delta y_{i,t-j} + \sum_{j=0}^{n} j_j uc_{i,t-j} + d_t + h_i + v_{it}$$

Both specifications raise several issues.[11] First, the way in which the user cost is measured. As mentioned, the most widely used solution is to simply assume that the user cost is common to all firms ($uc_{it} = uc_t$) and let time dummies take into account its time variations. This is unsatisfactory for our purposes, since we aim precisely at estimating the effect of interest rate movements on investment. As mentioned in section 2, two different strategies are possible. The effects of monetary policy can be modelled in two steps: constructing firm-specific proxies of the user cost of capital to estimate (2) and (3), along the lines of Chirinko, Fazzari and Meyer (1999); then, separately estimating the impact of a measure of monetary policy on the user cost of capital. Alternatively, one can directly use a measure of the monetary policy stance as a regressor in (2) and (3), omitting the time dummies; in this case it is again $uc_{it} = uc_t$, common to all firms in the same year. We follow the first approach. As a measure of monetary policy, we use the Bank of Italy repo rate, which is commonly adopted as a monetary policy indicator in the applied literature (for a discussion, see Gaiotti, 1999).

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discounted sum of profits can be estimated from the data.

[11] A third and widely used specification is the Euler equation derived from the first order conditions of the profit maximization problem, under the assumption of quadratic costs of adjustment, so yielding explicit dynamics (see Bond *et al*., 1997). Given the way it is derived, it embodies a consistent treatment of expectations and makes it possible to overcome the ambiguity in the interpretation of the possible finding of a significant effect of a cash flow (or profit) term added to equation (2) or (3). However, subsequent analyses have led to scepticism towards the ad hoc assumptions (e.g. the form of the adjustment cost) needed to implement the estimation. Some contributions (Chatelain and Teurlai, 2000, Whited, 1998) discuss possible ways out of this problem. At the present stage, though, we prefer to concentrate the analysis on the simpler specifications (2) and (3) above.

Another issue regards the role of financial variables. Information asymmetries can cause a departure from the model underlying (2) and (3). Distinguishing the behaviour of firms characterized by different degrees of financial constraint is crucial to understanding the transmission of monetary policy. The common approach is to add financial variables, namely cash flow or profits, to the right-hand side of (2) and (3). The estimated coefficients have been interpreted as reflecting the presence of financial constraints on investment, due to some information asymmetries or market imperfections conducive to a "broad" credit channel. However, the interpretation proved to be ambiguous (see the debate in Fazzari, Hubbard and Petersen, 1997 and Kaplan and Zingales, 1999 and 2000, as well as the surveys in Hubbard, 1998 and Schiantarelli, 1995); in the presence of adjustment costs, current investment depends on expected future profits, which may be correlated to current cash flow. The latter may be a proxy for expected profits rather than financial constraints.

For our purposes, the inclusion of cash flow in (2) and (3) is important to help assess the effects of monetary policy. We control for the cash flow/capital ratio in estimating (1) and (2), but also test whether the cash flow has a significant differential impact for groups of firms that can be thought as being characterized by different degrees of informational asymmetries. We also test whether the results are robust to the introduction of the stock of cash, instead of cash flow, as a financial variable. While not completely free from interpretation difficulties, the former indicator is likely to be much less correlated with expected profits.[12]

The investment equations above do not capture the first link in the monetary policy transmission chain, i. e. the effect of monetary policy on the main variables in the equation: the user cost, cash flow, sales. The impact of monetary policy can be felt through each of the three variables (Bernanke, Gertler and Gilchrist, 1996). The relative importance of each variable in policy transmission is an open question, which may also have implications for the importance of asymmetries. The last part of the exercise investigates the dynamic relation between a monetary policy indicator, the user cost, the cash flow and sales.

[12] Gilchrist and Himmelberg (1998) report such a finding for the US.

5. Data

To conduct our empirical analysis we selected a sub-sample of firms from the Company Accounts Data Service's database described above. The first two years of the sample were discarded, in order to construct the stock of capital at replacement value and to calculate the *I/K* ratio (where investment in year *t* is divided by capital at *t-1*): this left us with 550,000 observations. This definition of the *I/K* ratio also had the effect of excluding the first year in which each firm entered the sample, leaving us with 383,500 observations. Furthermore, we selected the firms for which information to construct the user cost (i. e. fiscal data) was available, retaining 195,000 observations for the period 1984-1999. After trimming for outliers (see the Appendix for details), imposing the condition of firms being continuously present for at least six years, and leaving out of the regressions the first five years, since the model is in first differences and we have lags in our specification, our final sample for estimation is composed of 7,026 firms and 43,912 observations.

The definition of the firm-specific variables that enter equations (2) and (3) is illustrated in detail in the Appendix. An important feature is the user cost of capital, which is constructed at firm level, using sector-specific depreciation rates and prices of output and investment and taking into account the influence of fiscal factors.[13]

We measure the interest rate at firm level as the ratio of interest expense over financial debt ("apparent" interest rate).[14] This approach allows us to obtain a firm-specific interest rate, but introduces a possible bias since the rate we obtain is an average rate, not a marginal rate, whereas the latter should be relevant for the firms' decisions. However, the distinction

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[13] For a complete description of the methodology used to calculate the user cost of capital for Italian firms, see De Mitri, Marchetti and Staderini (1998). They show that the introduction of the tax on net worth was one of the determinants of the increase in the user cost at the beginning of the 90s. Later, other fiscal reforms had opposite effects. The Tremonti Law (1994-96) provided substantial tax incentives for firms with historically high investment rates; the estimated reduction in the user cost was 10 per cent in 1994, 26 per cent in 1995 and 9 in 1996. Moreover, De Mitri, Marchetti and Staderini (1998) document a substantial heterogeneity in the user cost of capital across firms located in the South and in the North of Italy; for the former, up to 1994 the fiscal component of the user cost was lower, owing to tax reliefs. Recently, the introduction of the Dual Income Tax was meant to reduce the tax advantage of debt with respect to equity finance (see Staderini, 2000).

[14] De Mitri, Marchetti and Staderini (1998) use bank rates applied to individual firms, obtained from the Central Credit Register database (which are also defined as average rates). Apart from the fact that these yields only refer to bank lending, if we had followed their approach we would have lost a significant number of observations due to data availability.

may be of small importance for Italian firms, as most of the debt is either short-term (according to Table 2, debt with a maturity of less than one year is about 60 per cent of total debt for all firms) or at a floating rate. In the Appendix, we show that in our sample the behaviour of firms' interest expense is consistent with a rather high elasticity of the firm-specific debt rate to the policy interest rate, between 0.6 and 0.8.

The summary statistics of the final sample are presented in Table 4. The investment/capital and cash flow/capital ratios have a positively skewed distribution. Sales growth is larger for smaller firms. The within-firm standard deviation in Table 4, which measures the variability of each variable across time (cross-sectional variations are eliminated by subtracting the firm mean), is quite high for sales growth; by contrast, the investment/capital and cash flow/capital ratios are less volatile. The last column reports the coefficient of firm-specific time variation (see Chirinko, Fazzari and Meyer, 1999), which varies between 0 and 1 and indicates the proportion of time variation in each variable that cannot be explained by aggregate time effects.[15] For investment, cash flow and sales the coefficient is close to one, indicating that most time variation is firm specific, i. e. it is not explained by aggregate time effects. The coefficient is smaller for the user cost variable (about 0.68).[16] As expected, movements in the user cost depend largely but by no means completely on aggregate factors. The latter finding confirms the appropriateness of choosing a measure of the user cost at firm level.

Figure 2 shows the pattern of the main variables used in the estimation, which is broadly consistent with the discussion in section 3, although here we are using a smaller data set and considering ratios over capital, not over total assets. Investment/capital falls in 1992 and in 1993, recovers in 1995, and falls again in 1996, following the monetary tightening. The cash flow/capital ratio follows a similar pattern. The user cost rises after the 1992 restriction, falls in 1993 and rises again in 1996.

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[15] It is $(1\text{-}R^2)$ from a regression of each variable on aggregate time dummies, after subtracting firm means.

[16] These features are remarkably similar to those found by Chirinko, Fazzari and Meyer (1999) on their sample.

6. Empirical results

In this section we compare different specifications of the investment equations for our sample of Italian firms.

We present results based on both the accelerator and the error correction model. Each model is estimated using either the OLS (fixed effect) estimator or GMM first differences. It is well known that the OLS estimator may be inconsistent, since it does not take into account firm-specific effects (Arellano and Bond, 1991). The "within groups" estimator applies OLS after transforming the data into deviations from firm means, in order to eliminate the firm-specific effects. However, Nickell (1981) has shown that this would result in downward biased estimates of the autoregressive coefficients in panels with a small number of time periods. GMM first differences eliminates the firm-specific effects by differencing the equations, and then uses the lagged values of the endogenous variables as instruments. Instruments are needed since differencing induces serial correlation in the residuals, which would yield inconsistent estimates when the lagged dependent is included (a discussion is in Bond *et al*, 1997). However, depending on the choice of the instruments, GMM can lead to very large standard errors of the estimated coefficients. Hall, Mulkay and Mairesse (2000) compare GMM estimators and "within" estimators for an investment equation and find a "quite implausible" magnitude of many coefficients estimated by GMM. This leads them to prefer the "within" estimator when the number of time periods is reasonable (they have 12 annual observations for each firm).

For comparison and robustness check we present results obtained using both methods. While the presence of the lagged dependent variable in our specification may determine a bias in the "within" estimator, the choice of the instruments in our GMM estimation appears not to be unimportant.

6.1 The basic models

Table 5 compares the results from models (1) and (2) (augmented with the cash flow/capital ratio), using both estimation methods. Most results turn out to be robust to the choice of model and method, although the significance levels are sometimes affected.

GMM estimates are presented in column 1 (error correction model) and 2 (accelerator model). In the error correction model the total elasticity of the capital stock to sales is estimated to be low, about 0.16 (but not significantly different from zero). The impact of the user cost is negative and significant; the total elasticity is negative and less than one in absolute value, equal to –0.46.[17] The effect of the cash flow is positive and significant (about 0.13 in the first two years).[18] The accelerator model also features a significantly negative effect of changes of the user cost on the *I/K* ratio (with a total elasticity of 0.26); a positive effect of cash flow is also found. The effect of changes in sales is about 0.13 and it is now highly significant.

The results obtained with the within group OLS estimator (columns 3 and 4) confirm the negative impact of the user cost. In the accelerator specification the adjustment to the user cost is similar to – or slightly lower than – that found with GMM estimation. Cash flow matters (with a positive sign) in both cases and the sales variable is significant.

Some robustness checks on the model specification were also performed. First of all the ECM specification yields a higher negative coefficient for the user cost than those obtained with the ADL model; however the coefficient obtained with GMM seems sensitive to the choice of instruments. Results more in line with those of the ADL are obtained (results not shown) with a slightly different set of instruments.

A second check concerned the relatively low values found for the sales coefficients. Since the cash flow term can partly catch the effect of higher demand, we re-ran the regressions omitting the cash flow terms. The total effect of sales did increase in the ECM model (but only from 0.16 to 0.30). It remained virtually unchanged in the ADL specification.

A further check is reported in Table 6, where all models were re-estimated replacing the cash flow with the firm's liquidity (cash in hand and bank accounts). Conceptually, the

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[17] The total elasticity is defined as the sum of the coefficients on the lags of the user cost, divided by the coefficient on the error correction.

[18] For completeness, the table also reports the total effect of the cash flow/capital ratio on the capital stock. However, given the *ad hoc* nature of this term, which was not derived from explicit behavioural assumptions, and the endogenous nature of the cash flow/capital ratio, the total effect has no meaningful interpretation.

stock of liquidity plays the same role as the cash flow, as it is a proxy of the degree of financial constraints affecting the firm. However, it may be less affected by the difficulties mentioned in interpreting the sign of the cash flow coefficient, as liquidity is less likely to be a proxy of expectations of high future activity.[19] In fact, in our sample the correlation between lagged cash flow and sales is around 0.17, whereas it is only 0.03 between lagged liquidity and sales.[20] The model proves to be robust to the introduction of liquidity instead of cash flow. The sign and statistical significance of the various coefficients is not greatly affected; the degree of a firm's liquidity does affect investment with a positive sign; the long-run elasticity to the user cost is still less than one in absolute value. A consequence of replacing the cash flow with liquidity is that the elasticity to sales is now slightly larger and more precisely estimated than before.

Table 7 provides a last robustness check: the basic model is estimated including a set of interaction coefficients that allow for separate effects for manufacturing firms, in order to check whether their behaviour is different from the others, as could be suggested by some of the anecdotal evidence in section 3. However, no major differences are spotted.

All in all, the results vary across models but have some features in common. They indicate that the magnitude of the user-cost elasticity is rather limited, and much smaller than one, contrary to the usual assumptions of the neoclassical model, although the impact of the user cost on investment is negative and significant. On the other hand, the cash flow (or some other financial variable) and the behaviour of sales do matter in determining investment demand. Our estimates of the elasticity of capital demand to sales point to a value less than one, the value that would be implied by a Cobb-Douglas production function.

However, the point estimates of some coefficients are sensitive to the model chosen. In

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Emphasis should be put on the short or medium-run effect.

[19] According to the results of Gilchrist and Himmelberg (1998) on a panel of US firms, the present value of future cash flows is highly correlated with the present value of future marginal products of capital, while this is not a problem when stock measures of the financial status are used.

[20] As a measure of financial constraints, liquidity may have its own problems. Liquidity is the endogenous result of a decision by the firm. If the accumulation of liquidity reacts to investment decisions, the direction of causality may not be clear. However, unlike in the case of cash flow (which involves an ambiguity in the interpretation of the coefficient in the equation), this is mostly a problem of estimation (simultaneity). The latter can be addressed by the use of an appropriate set of instruments (in our case, liquidity enters the set of instruments with a lag of at least two years).

what follows, we choose the ADL model estimated with GMM as our preferred specification. The total effects are estimated more precisely than in the corresponding ECM model; since the precision of the estimates is satisfactory, we prefer GMM to OLS estimates to avoid possible biases.

6.2 Heterogeneity across firms

We adopt the ADL-GMM specification in the second column of Table 5 as a benchmark for analyzing the different impact of monetary policy variables on various groups of firms by interacting a group dummy with each of the coefficients. Nonetheless, for robustness check we also run the experiment with the ECM model. We consider the following three groups, which can proxy for the existence of financial constraints.

Small firms (with fewer than 200 employees). Small firms are traditionally considered more subject to liquidity constraints and information asymmetries; they are characterized by weaker balance sheets and are more opaque, so they should be more sensitive to the effect of a monetary policy tightening. In our sample, small firms are indeed more dependent on bank loans and on short-term debt. However, the greater sensitivity of small firms to monetary policy can be questioned on the grounds that closer bank-customer ties (typically more important for small firms) could mitigate the impact on both the cost of bank debt and the availability of finance following a monetary policy contraction.

Firms with a high proportion of intangible assets on their balance sheet (firms whose ratio of intangible assets to total assets is higher than 75 per cent of the distribution in at least one year). On average, firms recorded in this group have a ratio of intangible assets to total assets ten times greater than that for the other firms (3 per cent against 0.3 per cent). This corresponds to a ratio of intangible assets to the sum of intangible assets and fixed assets equal to 12.4 per cent for this group, against 3 per cent for the others. Intangible assets include R&D expenditures, patents, development and advertising costs and similar items recorded on the assets side. Investments in these assets are typically difficult to evaluate for outside lenders and cannot be used as collateral. As a consequence, these firms are more exposed to the “broad credit channel” of policy transmission (a discussion is also in Giannetti, 2000). All in all, this distinction should identify firms operating in activities where intangible capital is more important, hence more subject to information asymmetries.

Firms paying dividends (firms with non-negative payout for the whole sample period). This distinction has been often used in the literature. Firms not paying dividends may have chosen to do so, exploiting all internal resources to finance investment, because they face a high premium on the cost of external finance. In the US, the sensitivity to cash flow of firms that distribute dividends has been found to be lower (Fazzari, Hubbard and Petersen, 1999). As mentioned, however, the interpretation of this finding is ambiguous (Kaplan and Zingales, 1997). We chose the rather restrictive definition of firms paying non-negative dividends for the whole period in order to avoid problems encountered in the empirical literature linked to the possibility of switching between states in which dividends are distributed and states in which they are not (Schiantarelli, 1995). In the Italian case, characterized by a majority of unlisted firms, this dummy variable is meant to describe the behaviour of firms with excess cash.

The number of total observations falling in each group and the intersections between groups are shown in Table 8. The proportion of small firms in the total sample is roughly the same as the proportion of small firms in the group with a high share of intangible assets. This indicates that there is very little correlation between inclusion in the first group and inclusion in the second group. In contrast, firms paying dividends are more likely to be large than firms not paying dividends.

The results of the three sample splits for our benchmark ADL model are shown in Table 9; Table 10 also reports results for the ECM model. For each regression, the second column reports the coefficient on each variable interacted with a dummy assuming value 1 for that particular sub-group of firms, representing the differential coefficients for the same sub-group. For information, the bottom panel of each table also reports and compares the total effects of each explanatory variable and the across-groups difference. However, we consider the differences in short-run effects much more informative for our purposes than the long-run differences (particularly in the case of cash flow, the latter are of uncertain interpretation).[21]

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[21] The cash flow is introduced *ad hoc* into equations (2) and (3), to proxy for the effect of the lack of

The distinction between large and small firms appears to be relevant from the perspective of a broad credit channel. Small firms, which should be more affected by information asymmetries and credit constraints, are more affected by changes in the cash flow; for the same firms the deviations from the neoclassical model also show up in a larger user cost coefficient.

A larger effect of the cash flow on investment is also found for firms with less balance sheet assets to use as collateral; this is again in line with our priors, as the availability of collateral is a means of overcoming problems of information asymmetries. By contrast, the results for firms paying or not paying dividends do not appear to be easily interpretable in the light of the credit channel theory (possibly implying that this characteristic is not relevant here).

More specifically, the impact of the *user cost* (as well as the overall long-run elasticity) is always negative. It is significantly larger, in absolute value, for small firms. It is also larger for firms with intangible assets. The short run impact of the *cash flow* on investment is significantly stronger for small firms, as well as for firms with intangible assets.

To check the results, and, in particular, to better interpret the results for the dividends split, we re-run our model using liquidity instead of cash flows as the balance sheet variable. The results obtained (not reported) still indicate a higher total elasticity of investment to liquidity for firms with intangible assets and a lower one for firms paying dividends (in this case conforming to the assumptions).

7. More on monetary policy and investment

What do the above results tell us about the importance of asymmetries in monetary transmission stemming from a broad credit channel? Answering this requires a further step, as we need to know how monetary policy affects the determinants of investment that we identified in the preceding section. That is, in order to evaluate the relative importance of different channels of transmission of monetary policy to investment, the results have to be

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liquidity on current expenditure of the firm. Given this assumption, the long-run coefficient of cash flow implied in the solution of (2) and (3) is not easy to interpret.

integrated with an estimate of the impact of changes in interest rates on the user cost of capital, the cash flow and sales. [22]

Following the approach taken by Fazzari (1993), we combine the micro equations estimated above with macro evidence on the first link in the transmission process, obtained from other sources. We are thus able to compute not only the total effect of monetary policy on investment for each group of firms, but also the portion of that effect transmitted through each explanatory variable in the investment equation.

As a first step, we consider the results from a simulation of the quarterly model of the Italian economy (Banca d'Italia, 1986), where policy rates were temporarily increased by one percentage point, for two years. According to the results (reported in Table 11A), the increase in the nominal interest rate determines an increase in the user cost of capital[23] of around 3 per cent over the same period.[24] Firms' cash flow (as a proportion of the stock of capital) deteriorates by about 3.4 per cent, due to the effect of higher interest rates both on value added and on interest expense.[25] Value added (the closest equivalent to sales) decreases by about 0.7 per cent.

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[22] It should be noted that "asymmetries" could also be at work in the first stage of transmission, thus reinforcing or offsetting the asymmetries that we found in the investment equation estimated in the previous section. Knowing the importance of the different channels can shed light on this issue, too, but identifying these effects goes well beyond the scope of this paper. Asymmetries in the transmission of policy to the user cost and the interest burden (hence the cash flow) may exist for the firm groups examined in the first part of the paper. Information asymmetries may determine the extent to which changes in policy rates are transferred to firm-specific lending rates, so that "opaque" firms may again suffer more from the restriction. On the other hand, as already mentioned, smaller firms may enjoy closer customer relationships with banks and somehow be shielded from interest rate changes. Moreover, asymmetries in the response of firms' sales to monetary policy may stem from an "interest rate" channel, as the interest sensitivity of the demand for the output of firms operating in the construction or capital goods sectors may be larger (Guiso *et al*, 2000).

[23] The definition of the user cost in the quarterly model database is basically equivalent to the one we used (see Banca d'Italia, 1986, and Terlizzese, 1994).

[24] The magnitude of this effect depends crucially on assumptions made on long-term interest rates, as these represent a portion of the average interest rate included in the user cost formula (see definition in the Appendix). The reported results correspond to an elasticity of about 0.3; such a small elasticity depends on the assumption that long-term interest rates are determined by the expectation theory and that perfect foresight holds. Thus, a temporary shock to the short-term rate has only a limited effect on long-term rates and on the user cost of capital.

[25] In the quarterly model, cash flow is defined as value added, less labour income, less direct taxes, less interest expense (variable *autimpd* in Banca d'Italia, 1986). This definition is also conceptually equivalent to ours.

As a second step, we summarize the properties of the regressions presented in the previous section over an horizon which is relevant to our experiment. Table 11B reports the (cumulated) response of the *I/K* ratio to each individual determinant of the equation, which is approximately equal to the percentage effect on the stock of capital;[26] the effect is computed after three years, assuming a persistent change in each of the explanatory variables. The medium-run rather than the long-run response to these variables is relevant to judge the effects of monetary policy, as the user cost, the cash flow/capital ratio and sales are not permanently affected by monetary policy. The table confirms that the effect of cash flow is larger for the two groups of firms more exposed to financial constraints; the same is true for the effect of the user cost.

Finally, the two sets of results are combined together in Table 11C, which shows the outcome of a joint simulation including both the macro effects of monetary policy on investment determinants and the effect on investment through micro equations. As before, the experiment is a one-percentage point increase in policy rates for two years. In the table, we report the cumulated effect on the investment/capital ratio (the percentage effect on the stock of capital) after three years.

Two features of the results should be emphasized. First, most of the effect of monetary policy is transmitted through the user cost variable. This variable explains between 65 and 70 per cent of the total effect of monetary policy on investment. The effect transmitted through the cash flow is also not negligible, but it is smaller. The effect through sales is relatively small. Secondly, and not surprisingly given the results in the previous section, the effect of monetary policy is larger for small firms and firms with a larger share of intangible assets. The difference comes from the effects of both the user cost and the cash flow.

In order to check whether differences are large from a policy perspective, we express the results for the first two years of the previous simulation as percentage deviations of investment from baseline (Table 12).[27]

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[26] See equation (A13) in the Appendix.

[27] The deviations of investment from baseline in Table 12 are approximated by dividing the effect on *I/K* in the first and in the second year by the average value of *I/K*. See equation (A16) in the Appendix.

The table shows that, for the whole sample of firms, investment decreases by about 4 per cent in each year after the monetary restriction. The size of this effect is broadly consistent with the properties of structural macro models of the Italian economy (although the change is faster). However, the decrease is always larger for small firms and firms with a larger share of intangibles. The difference between the response of investment in large and small firms is on average 1.6 percentage points each year; the investment of firms with a larger share of intangibles decreases by 1.3 points more than for the other group in the second year.

From a domestic standpoint, these asymmetries are of an important magnitude (considering that gross fixed capital in Italy grew at an average annual rate of 2.4 per cent over the period 1985-2000, with peak annual growth of 6.7 per cent).

In principle, these asymmetries could also affect the transmission of monetary policy in the euro area. In practice, however, they should not result in large cross-country differences. According to Eurostat statistics on small and medium-sized enterprises, the turnover of firms with fewer than 250 employees accounts for about 71 per cent of the total in Italy, against 57 per cent in the euro area. Considering an investment/GDP ratio of around 20 per cent, the differential effect on investment between large and small firms would mechanically determine a larger effect of monetary policy on Italian GDP than on euro-area GDP, of about 0.05 percentage points in each of the two years. Although not negligible, the difference is not very large either, particularly considering the margin of uncertainty surrounding the effects of monetary policy on GDP. However, a proper conclusion on this issue would require complementing our result with a cross-country comparison, which goes beyond the scope of this paper.

8. Conclusions

The user cost of capital, the cash flow and sales all affect the investment decisions of Italian firms. Cash flow significantly enters the investment equations even when a firm-specific measure of the user cost is included.

All in all, a number of features of our results are consistent with the existence of a channel of monetary transmission operating through firms' balance sheets. Financial constraints enter the investment equation, both when measured with cash flow and when measured as the stock of liquidity available to the firm. Moreover, the impact of financial variables, whatever the definition, is significantly stronger for small firms; it is also stronger for firms who have a larger share of intangible assets, which are of difficult evaluation and cannot be used as collateral. While each of these results, taken separately, is subject to different interpretations, taken together they all point in the same direction.

We assessed the quantitative importance of these factors in determining differences in the effect of monetary policy on the investment of firms with different characteristics. We concluded that the differences are not negligible, taking as a benchmark the average growth rate of investment. However, the differences in the GDP response to monetary policy between Italy and the euro area that would derive from a mechanical extrapolation of these results seem quite limited.

Thus, while transmission asymmetries could exist across euro-area countries as a result of a balance sheet channel, they are not likely to be so large as to be systematically relevant for the area-wide policymaker. Rather, we draw a different implication from the existence of a balance sheet channel of transmission: the same policymaker would be well advised to take a systematic look at financial conditions of different firms in the area, in order to assess the current monetary stance more accurately.

Appendix

The sample

The source of information on firms' balance sheets, profit and loss accounts and flow of funds is the Company Accounts Data Service (*Centrale dei Bilanci*). Data are collected since 1982 from a consortium of banks; the sample is not randomly drawn since firms enter only by borrowing from one of the banks in the consortium. Balance sheets are reclassified in order to ensure cross-sectional comparability.

The descriptive analysis in section 3 is based on the whole sample of firms; firms with values of the ratio of gross investment to total assets lower than the first percentile or higher than the 99th percentile were excluded. Data for 1982 are to be interpreted with caution, since many firms had missing data in the first year of the sample. In 1998, the whole sample included 30,991 firms, with total assets equal to 820 € billion. Firms in the manufacturing sector represent 50 per cent of the sample in terms of total assets; the construction sector is excluded. As discussed by Guiso *et al.* (1999) the focus on the level of borrowing in the Company Accounts Data Service skews the sample toward larger firms.

On the basis of the last census, the total database of the Company Accounts Data Service accounted for approximately 46 per cent of total value added of the economy. Firms in the database accounted for 13.9 per cent of the total value added of all firms with up to 49 employees, 80 per cent of that of firms with between 50 and 199 employees, 80.2 per cent of that of firms with between 200 and 499 employees and 87 per cent of that of firms with more than 499 employees.

As explained in the paper, the sample selected for the estimation is composed of 7,026 firms for a total of 43,912 observations. The correction for outliers was made in the following way. First, we deleted firm-year data when there were negative values of sales or value added Y, total assets A, the stock of capital K, total debt B, or a missing number of employees. Second, we excluded firm-year data that fell in the first and the 99th percentile of any of the following ratios: investment over capital (I/K), sales over capital (Y/K), cash flow over capital (CF/K), liquid assets over capital.

The variables

The variables used in the estimation are defined as follows (a subscript i stands for the firms, s for the sector, t for the time period):

Gross investment (excluding leasing): total new fixed assets.

Capital stock: the replacement value of property, plant and equipment. The replacement value was obtained from the book value, by means of a perpetual inventory method:

(A1)
$$K_{i,t} = \frac{p^I_{i,t} I_{i,t}}{p^I_{s,t}} + (1 - d_s) K_{i,t-1}$$

where investment in year t is deflated by a sector price of investment and the economic depreciation rate d_s is calculated at the sector level (two-digit, following ESA79). The starting value for the first year is calculated with the formula used by Bond *et al.* (1997). The first year book value is deflated using the sector price of investment measured $Tmean_i$ years before. $Tmean_i$ is the corrected average age of the firm's capital, which is computed using the sector useful life of the capital goods ($Tmax_s$) and the share of goods already depreciated in the first year for which the firm's accounts are available. The formula is corrected to allow for the fact that depreciation for tax purposes is faster than economic depreciation.[28]

(A2)
$$Tmean_i = Tmax_s \frac{DEPR_{i,t0}}{p_K K_{i,t0}} \frac{1}{2} \quad if \quad Tmax_s \frac{DEPR_{i,t0}}{p_K K_{i,t0}} < 8$$

(A3)
$$Tmean_i = Tmax_s \frac{DEPR_{i,t0}}{p_K K_{i,t0}} - 4 \quad if \quad Tmax_s \frac{DEPR_{i,t0}}{p_K K_{i,t0}} > 8$$

where $DEPR$ is the total book value of accumulated depreciation.

[28] Equation (A2) implies that full tax depreciation is obtained in half the time of economic depreciation. According to equation (A3), used for longer lived capital, assets are fully depreciated for tax purposes 4 years before their full economic depreciation (the latter case is not frequent in our sample).

Sales: total net sales.

Cash flow: net profit plus provisions for depreciation.

Liquidity: cash in hand and bank accounts.

Debt: total financial debt (short and long-term).

All variables are deflated using a sector-specific deflator for output prices.

User cost of capital: derived from the firm's optimization problem (see Hall, Mulkay and Mairesse, 1999 and 2000, and Cohen, Hassett and Hubbard, 1999):

(A4) $$R_{i,t} = \frac{p^I_{s,t}}{p_{s,t}} \left(r_{i,t} + d_s - (1-d_s) \frac{\Delta p^I_{s,t+1|t}}{p^I_{s,t}} \right) \left(\frac{1 - itc_{i,t} - t_t z_s}{1 - t_t} \right)$$

In (A4), p_s^I is the sectoral price of investment, p_s is the sectoral price of output, d_s is the sectoral depreciation rate, $\Delta p^I_{s,t+1|t} / p^I_{s,t}$ is the expected change in the sectoral price of investment, obtained from the survey of manufacturing firms conducted each year by the Bank of Italy (INVIND), $r_{i,t}$ is the interest rate (see below).

The definition (A4) also takes into account the effect of tax variables, which enter the last term on the right-hand side.[29]

The tax rate on profits (t_t), which affects the denominator (an increase in the tax rate leads to a higher user cost), is defined at the economy-wide level.[30]

The tax deductibility of depreciation charges ($t_t\ z_s$) reduces the cost of capital. (z_s) is the actual value of depreciation allowances per unit of investment. These are defined at the sectoral level and determined according to Italian law, which distinguishes between vehicles

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29 For details, see De Mitri, Marchetti and Staderini (1998).

30 A regional differentiation was introduced for the part of the period during which regions in the South benefited from a lower tax rate. In 1983, the tax rate was 46 per cent in the North and 36 in the South; it increased to a maximum of 53.2 per cent in 1995; in 1998 it was 41.25 per cent.

and machinery investment. Averages for each sector are computed based on the share of these two items in investment.[31]

The variable $itc_{i,t}$ [32] represents the investment tax credit (per unit of investment). In 1984 companies were granted a tax credit of 6 per cent of the cost of newly acquired capital goods, which they could deduct from VAT payments.[33] Between 1994 and 1996 the Tremonti Law provided a partial tax reduction for reinvested earnings; this tax credit can be reconstructed at firm level.[34] Until 1994 preferential treatment was granted to firms located in the South.

Properties of the interest rate

The interest rate $r_{i,t}$ in (A4) is calculated at firm level using the following definition:

$$r_{i,t} = \frac{gross\ debt_{i,t} * debt\ rate_{i,t} * (1 - t_t) + equity_{i,t} * equity\ rate_t}{gross\ debt_{i,t} + equity_{i,t}} \qquad \text{(A5)}$$

where the equity rate is assumed equal to the long-term interest rate, and

$$debt\ rate_{i,t} = \frac{interest\ expense_{i,t}}{financial\ debt_{i,t}} \qquad \text{(A6)}$$

As mentioned in the text, the debt rate in (A6), while having the advantage of being a firm-specific variable, is an average rather than a marginal rate. In the Italian context, however, a large share of firms' debt is either short term or at a floating rate; a change in current rates is thus likely to be largely reflected in the average debt rate.

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[31] Each year a firm can deduct from income a given percentage of the historical cost of each investment good, plus a further amount following an accelerated method. The actual values differ for vehicles and machinery investment. Defining a_i as the depreciation in each year, as a percentage of capital, for each category, we computed the average value of depreciation allowances as $\sum_{i=1}^{n} a_i / (1+r)^{i-1}$, where r is an average interest rate.

[32] We also included in this variable, treated as a negative tax credit, the effect of the introduction of the 0.75 per cent tax on companies net worth. The tax was lifted in 1998.

[33] In 1984 the incentive regarded all manufacturing and extractive firms; in 1986 it was reintroduced for Southern firms for five more years.

To check whether this applies, we estimate the relation between interest expense and the policy rate. We assume a partial adjustment mechanism linking the debt rate to the policy rate $\bar{r}_t$:

(A7) $$debt\ rate_{i,t} = a_i + b_0\,\bar{r}_t + b_1\,\bar{r}_{t-1} + g\ debt\ rate_{i,t-1}$$

Estimation of (A7) would not be advisable, since $\bar{r}_t$ is an aggregate variable. The number of degrees of freedom along the time dimension would be limited in our sample and time effects could not be included. We substitute (A6) in (A7) and obtain:

(A8) $$\begin{aligned} interest\ expense_{i,t} &= a_i\,(financial\ debt_{i,t}) + b_0\,(\bar{r}_t * financial\ debt_{i,t}) + \\ &+ b_1\,(\bar{r}_{t-1} * financial\ debt_{i,t}) + g\,(financial\ debt_{i,t} * debtrate_{i,t-1}) \end{aligned}$$

Dividing by K_{t-1} and assuming that the firm debt/capital ratio does not vary much over time, we estimate:

(A9) $$\begin{aligned} \frac{interest\ expense_{i,t}}{K_{i,t-1}} &= d_i + a\,\left(\frac{financial\ debt_{i,t}}{K_{i,t-1}}\right) + b_0\left(\bar{r}_t\,\frac{financial\ debt_{i,t}}{K_{i,t-1}}\right) + \\ &+ b_1\left(\bar{r}_{t-1}\,\frac{financial\ debt_{i,t}}{K_{i,t-1}}\right) + g\,\left(\frac{interest\ expense_{i,t-1}}{K_{i,t-2}}\right) + e_t \end{aligned}$$

[34] In each year firms were allowed to deduct from pre-tax earnings 50 per cent of their capital spending if such expenditure for the year exceeded the average investment expenditures for the preceding five years.

Dependent variable: $interest\ expense_{t}/K_{t-1}$	(1)		(2)		(3)	
c	-0.005	**	-0.005	**	-0.002	*
	0.001		*0.001*		*0.001*	
$interest\ expense_{t-1}/K_{t-2}$	0.17	**	0.27	**	0.17	**
	0.02		*0.02*		*0.03*	
$debt_{i,t}/K_{i,t-1}$	-0.01	*	-0.01	*		
	0.005		*0.006*			
$debt_{i,t-1}/K_{i,t-2}$	0.011	*				
	0.006					
$\bar{r}_t * debt_{i,t}/K_{i,t-1}$	0.76	**	0.78	**	0.6	**
	0.05		*0.05*		*0.07*	
$\bar{r}_{t-1} * debt_{i,t}/K_{i,t-1}$	0.06				0.18	**
	0.06				*0.04*	
$m2$	3.50%		1.70%		4.50%	

OLS estimation with fixed effects

The results (for various lag lengths) are shown in the table above. In all cases, they imply that between 60 and 80 per cent of a change in the policy rates is transmitted to the contemporaneous debt rate. In the long run, the policy rate has a full effect on the debt rate, as the sum of β_0, β_1 and γ is about 1 in all regressions.

Capital, investment and the investment/capital ratio: some arithmetic

In section 7 we discussed the (short and medium-run) percentage effect of a change in monetary policy on the stock of capital and on investment. To proxy these variables, we used simple transformations of the deviation of the I_t/K_{t-1} ratio from its baseline value (which can be directly obtained from the estimated equations).

According to a first transformation, the percentage deviation of the capital stock from the baseline can be approximated by the cumulated sum of the deviations of I_t/K_{t-1}, over the relevant period. This can be derived from the identity:

(A10) $$K_t - K_{t-1} = I_t - dK_{t-1}$$

Denoting an alternative path of capital and investment (e. g. after a policy shock in *t=1*) as $\tilde{K}_t, \tilde{I}_t$, equation (A11) can be rewritten as:

(A11) $$\tilde{K}_t - \tilde{K}_{t-1} = \tilde{I}_t - d\tilde{K}_{t-1}$$

Subtracting (A11) from (A10), and after some transformations, we obtain:

(A12) $$\frac{\tilde{K}_t - K_t}{K_t} = \left(\frac{K_{t-1}}{K_t}\right)\left[\frac{\tilde{I}_t}{\tilde{K}_{t-1}} - \frac{I_t}{K_{t-1}}\right] + \left(\frac{K_{t-1}}{K_t}\frac{\tilde{K}_t}{\tilde{K}_{t-1}}\right)\left[\frac{\tilde{K}_{t-1} - K_{t-1}}{K_{t-1}}\right]$$

For reasonable values of the rate of growth of capital, $K_t/K_{t-1}, \tilde{K}_t/\tilde{K}_{t-1} \cong 1$ (in our sample, the average K_t/K_{t-1} is 1,04). Then, (A12) becomes

(A13) $$\frac{\tilde{K}_t - K_t}{K_t} \cong \left[\frac{\tilde{I}_t}{\tilde{K}_{t-1}} - \frac{I_t}{K_{t-1}}\right] + \left[\frac{\tilde{K}_{t-1} - K_{t-1}}{K_{t-1}}\right]$$

which, by repeated substitution, implies that the percentage deviation of capital from the baseline can be approximated as the cumulated sum of the deviations of I_t/K_{t-1}.

A second approximation is used in Table 12; the deviation of investment from baseline is derived as the deviation of I_t/K_{t-1}, divided by the mean value of I_t/K_{t-1} itself. It can be derived from:

(A14) $$\frac{\tilde{I}_t/\tilde{K}_{t-1} - I_t/K_{t-1}}{I_t/K_{t-1}} = \frac{\left(\frac{K_{t-1}}{\tilde{K}_{t-1}}\right)\tilde{I}_t - I_t}{I_t}$$

In the first few periods of the simulation it is $\tilde{K}_{t-1}/K_{t-1} \cong 1$ (this holds exactly for t=1). Then, for t small (Table 12 in the main text reports values for t = 1, 2):

(A15) $$\frac{\tilde{I}_t - I_t}{I_t} \cong \frac{K_{t-1}}{I_t}\left(\frac{\tilde{I}_t}{\tilde{K}_{t-1}} - \frac{I_t}{K_{t-1}}\right)$$

In the text, we further approximate (A15) as:

(A16) $$\frac{\tilde{I}_t - I_t}{I_t} \cong \left(\overline{IK}\right)^{-1}\left(\frac{\tilde{I}_t}{\tilde{K}_{t-1}} - \frac{I_t}{K_{t-1}}\right)$$

where $\overline{IK}$ stands for the average I_t/K_{t-1} ratio over the sample.

Tables and figures

Table 1

Financial structure of firms

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Size of the sample																	
1 Total employment (x 1000)	2,578	3,068	3,180	3,283	3,225	3,151	3,200	3,277	3,329	3,397	3,280	3,415	3,551	3,474	3,528	3,610	3,360
2 Total assets (billion euro)	149	224	267	303	324	350	391	438	497	578	602	673	722	764	773	844	820
3 Total number of firms	21,589	22,488	26,447	29,694	31,747	32,435	34,050	35,690	37,195	37,224	36,813	39,038	42,535	34,669	33,074	35,178	30,991
Assets structure (as % of total assets)																	
4 Total real fixed assets	27.57	36.60	33.59	32.28	31.48	30.81	29.43	29.01	30.13	32.54	32.88	32.95	32.82	31.50	32.07	30.45	30.78
5 Total financial fixed assets	6.63	5.96	6.43	6.68	7.74	7.61	8.51	8.40	8.34	8.26	8.61	11.13	9.71	9.80	10.25	11.87	12.14
6 Total inventories	21.87	16.80	17.11	17.57	16.87	16.58	16.16	16.42	16.36	15.76	15.12	13.84	14.12	14.28	13.73	13.78	13.41
7 Total trade credit	32.22	28.29	29.14	29.38	29.02	28.68	29.52	30.14	29.33	28.20	28.22	26.98	28.25	29.30	29.40	29.39	28.30
8 Total all other assets	11.71	12.35	13.73	14.09	14.90	16.32	16.39	16.03	15.83	15.24	15.18	15.11	15.11	15.12	14.54	14.50	15.38
Liabilities structure (as % of total liabilities)																	
9 Loans of credit institutions	25.28	23.36	24.45	23.49	22.42	22.11	21.62	22.79	23.80	23.01	24.97	22.53	21.58	21.03	20.08	19.86	19.62
9a with maturity < 1 year	15.59	12.37	14.27	13.70	13.49	13.12	13.47	14.54	15.12	14.45	15.75	14.65	13.73	13.45	12.50	12.67	12.70
9b with maturity > 1 year	9.69	10.99	10.18	9.79	8.93	8.99	8.15	8.24	8.67	8.56	9.22	7.88	7.85	7.59	7.57	7.18	6.92
10 Debt securities	1.25	5.83	5.05	4.88	4.88	4.85	4.41	4.01	3.58	3.44	2.95	2.11	1.93	1.80	1.84	1.80	1.68
11 Trade debt	25.17	22.54	23.16	23.54	23.15	23.82	24.39	24.80	24.23	22.81	23.34	23.32	24.62	25.33	25.05	25.17	24.21
12 All other debt	8.39	6.82	6.71	6.39	6.32	5.78	6.34	6.24	6.83	7.71	8.27	11.82	9.69	8.98	9.91	9.75	9.70
13 Equity and reserves	22.92	24.90	24.05	24.52	25.94	25.81	25.00	24.81	24.68	26.25	23.63	23.28	25.13	25.03	26.19	26.72	27.47
14 All other liabilities	17.00	16.56	16.58	17.19	17.29	17.65	18.23	17.35	16.88	16.78	16.84	16.94	17.05	17.83	16.94	16.71	17.32
Flow indicators (as % of total assets)																	
15 Gross investment	1.99	5.90	5.58	6.05	6.40	6.82	6.80	6.99	6.69	6.44	6.46	5.23	5.34	5.47	5.56	5.20	5.57
16 Investment in intangibles	0.13	0.36	0.37	0.41	0.49	0.47	0.53	0.61	0.60	0.62	0.74	0.52	0.58	0.52	0.66	0.61	0.69
17 Cash flow	5.84	6.45	7.76	8.24	9.07	9.42	9.43	8.83	7.86	7.48	6.39	6.18	7.72	8.19	7.97	8.34	8.72
18 Net operating profit	8.85	8.83	9.60	9.33	9.01	8.57	8.82	8.43	7.48	6.80	6.20	6.06	6.85	8.36	7.63	7.65	8.08
19 Interest and similar charges	7.12	6.93	6.33	5.70	4.66	3.91	3.88	4.00	4.23	4.26	4.99	4.96	3.63	3.85	3.38	2.77	2.30

Source: Company Accounts Data Service (*Centrale dei Bilanci*). Averages weighted with total assets.

Table 2

Financial structure of firms by groups

	all firms	small manufacturing	large manufacturing	small service	large service
Assets structure (as % of total assets)					
Total real fixed assets	30.62	24.13	26.12	20.98	52.61
Total financial fixed assets	12.00	6.42	17.66	7.53	12.10
Total inventories	13.60	19.24	14.10	16.96	3.98
Total trade credit	28.84	36.08	28.09	38.48	17.55
Total all other assets	14.94	14.13	14.03	16.05	13.75
Liabilities structure (as % of total liabilities)					
Loans of credit institutions	19.74	25.26	19.02	23.42	14.09
with maturity < 1 year	12.69	18.76	11.77	17.42	6.07
with maturity > 1 year	7.05	6.50	7.25	6.00	8.02
Debt securities	1.74	1.20	1.06	0.84	3.87
Trade debt	24.69	27.47	22.32	33.21	18.17
All other debt	9.73	7.41	8.70	9.09	11.20
Equity and reserves	27.09	25.56	32.27	20.04	30.12
All other liabilities	17.02	13.10	16.64	13.40	22.55
Flow indicators (as % of total assets)					
Gross investment	5.38	5.23	5.25	3.88	7.73
Cash flow	8.53	7.20	9.49	5.23	12.49
Net operating profit	7.87	7.43	8.26	6.47	9.98
Interest and similar charges	2.53	2.81	2.33	2.80	2.02
short term bank debt	*64.3*	*74.3*	*61.9*	*74.4*	*43.1*
leverage	*53.5*	*57.0*	*47.1*	*62.5*	*49.2*

Source: Company Accounts Data Service (*Centrale dei Bilanci*). Averages 1997-98, weighted with total assets.

Table 3

Investment and cash flow in particular episodes: 1989-1998

(changes in the variables with respect to the preceding period)

	1989 expansion, monetary restriction	1990-91 expansion	1992 recession, monetary restriction	1993 recession	1996 recession	1997-98 expansion
Average lending rate	0.70	-0.20	1.70	-1.80	0.22	-3.20
All firms						
Gross investment/assets	0.19	-0.42	-0.11	-1.23	0.09	-0.18
Cash flow/assets	-0.60	-1.16	-1.28	-0.21	-0.22	0.56
Interest and similar charges	0.12	0.25	0.74	-0.03	-0.47	-0.84
Small manufacturing						
Gross investment/assets	-0.24	-0.24	-0.49	-0.78	-0.47	-0.05
Cash flow/assets	-0.71	-1.08	-1.27	-0.38	-0.39	-0.28
Interest and similar charges	0.30	0.29	0.72	-0.37	-0.36	-0.92
Large manufacturing						
Gross investment/assets	0.37	-0.47	-0.09	-0.79	0.01	-0.28
Cash flow/assets	-0.92	-1.95	-1.98	0.01	-0.82	0.64
Interest and similar charges	0.26	0.32	0.69	-0.11	-0.37	-0.82
Small services						
Gross investment/assets	-0.23	-0.06	0.27	-1.39	-0.02	0.13
Cash flow/assets	-0.55	-0.63	-1.53	-0.67	0.14	-0.12
Interest and similar charges	0.15	0.26	0.94	-0.16	-0.39	-0.80
Large services						
Gross investment/assets	1.13	-0.98	0.03	-2.17	0.82	-0.52
Cash flow/assets	0.04	-0.27	-0.02	-0.36	0.01	1.56
Interest and similar charges	-0.41	0.14	0.58	0.15	-0.59	-0.83

Source: Company Accounts Data Service (*Centrale dei Bilanci*). Averages, weighted with total assets.

Table 4

Summary statistics for the final sample

Variable	Mean	Median	Within firm standard deviation	Firm-specific time variation
I_t / K_{t-1}	0.119	0.073	0.139	0.986
Δs_t	0.022	0.025	0.664	0.964
CF_t / K_{t-1}	0.178	0.135	0.159	0.969
Δuc_t	-0.0126	-0.006	0.187	0.679

Source: Company Accounts Data Service (*Centrale dei Bilanci)*.

Sample period: 1989-99. *I/K* is investment over capital at replacement value; *Ds* is the change in the logarithm of real sales; *CF/K* is cash flow over capital; *Duc* is the change in the logarithm of the user cost. The within firm standard deviation is computed after subtracting firm by firm means of each variable from each observation; this statistic measures the variation over time. The firm-specific time variation is $1\text{-}R^2$ from a regression of each mean differenced variable on time dummies. See Chirinko, Fazzari and Meyer (1999).

Investment equations

Dependent variable: I(t)/K(t-1)
Sample: 1989-1999 - 7026 firms - 43912 obs.

	GMM(1)	GMM(2)	Fixed effect	Fixed effect
$I_{(t-1)}/K_{(t-2)}$	-0.019	0.133 **	-0.102 **	-0.019 **
	(0.028)	*(0.027)*	*(0.008)*	*(0.008)*
$I_{(t-2)}/K_{(t-3)}$		-0.009		-0.096 **
		(0.019)		*(0.006)*
$I_{(t-3)}/K_{(t-4)}$		-0.006		-0.078 **
		(0.015)		*(0.007)*
$\Delta s_{(t)}$	-0.007	0.018	0.047 **	0.040 **
	(0.032)	*(0.035)*	*(0.004)*	*(0.004)*
$\Delta s_{(t-1)}$	0.018	0.044 **	0.058 **	0.040 **
	(0.034)	*(0.011)*	*(0.004)*	*(0.004)*
$\Delta s_{(t-2)}$		0.037 **		0.030 **
		(0.011)		*(0.004)*
$\Delta s_{(t-3)}$		0.016 **		0.024 **
		(0.005)		*(0.003)*
$(k-s)_{(t-2)}$	-0.153 **		-0.204 **	
	(0.027)		*(0.006)*	
$s_{(t-2)}$	-0.129 **		-0.138 **	
	(0.042)		*(0.006)*	
uc(t)	-0.081 **		-0.147 **	
	(0.027)		*(0.005)*	
uc(t-1)	0.02		0.013 **	
	(0.021)		*(0.004)*	
uc(t-2)	-0.01		0.002	
	(0.017)		*(0.004)*	
Δuc(t)		-0.104 **		-0.124 **
		(0.026)		*(0.004)*
Δuc(t-1)		-0.057 *		-0.081 **
		(0.022)		*(0.004)*
Δuc(t-2)		-0.054 *		-0.051 **
		(0.022)		*(0.004)*
Δuc(t-3)		-0.012		-0.029 **
		(0.008)		*(0.003)*
CF(t)/K(t-1)	0.078 **	0.273 **	0.077 **	0.104 **
	(0.030)	*(0.041)*	*(0.009)*	*(0.011)*
CF(t-1)/K(t-2)	0.069 *	-0.006	0.008	0.041 **
	(0.033)	*(0.038)*	*(0.009)*	*(0.009)*
CF(t-2)/K(t-3)	-0.051	-0.004	0.014	0.035 **
	(0.027)	*(0.043)*	*(0.008)*	*(0.009)*
CF(t-3)/K(t-4)		0.103 *		0.034 **
		(0.052)		*(0.008)*
m_2	1.24 (p=.214)	-.104(p=0.917)	-1.5 (p=.135)	-.074(p=0.941)
Sargan test	115.0 (p=.115)	142.0(p=.066)		

Total effect of sales	0.16	0.130 **	0.32 **	0.112 **
	(0.221)	*(0.050)*	*(0.023)*	*(0.010)*
Total effect of user cost	-0.46 *	-0.26 **	-0.65 **	-0.24 **
	(0.224)	*(0.077)*	*(0.041)*	*(0.012)*
Total effect of cash flow	0.63	0.41 **	0.49 **	0.18 **
	(0.360)	*(0.102)*	*(0.079)*	*(0.014)*

Significance levels: **=1%, *=5%

I/K: investment over lagged capital at replacement value; *uc*: log of the user cost; *s*: log of sales; *CF/K*: cash flow over capital; *k*: log of capital. *m2* is the test of second-order autocorrelation (p-value in parenthesis); *Sargan* is the test of overidentifying restrictions (p-value in parenthesis). (1) Instruments: I/K(t-2); (k-s)(t-4); Δs(t-2 to t-6); "apparent" interest rate (t-4); CF/K (t-4 to t-5); control for time dummies. (2) Instruments: I/K (t-2 to t-9); Δs(t-2 to t-4); Δuc(t-4); CF/K (t-2); control for time and industry dummies.

Table 6

Alternative specification: liquidity as a measure of financial constraints

Sample: 1989-1999 - 7026 firms - 43912 obs.

	GMM(1)		GMM(2)		Fixed effect		Fixed effect	
$I_{(t-1)}/K_{(t-2)}$	-0.001		0.162	**	-0.109	**	-0.014	
	0.025		*0.013*		*0.008*		*0.008*	
$I_{(t-2)}/K_{(t-3)}$			0.014				-0.092	**
			0.008				*0.006*	
$I_{(t-3)}/K_{(t-4)}$			0.013	*			-0.076	**
			0.006				*0.006*	
$\Delta s_{(t)}$	0.079	*	0.036		0.062	**	0.054	**
	0.035		*0.033*		*0.004*		*0.004*	
$\Delta s_{(t-1)}$	0.104	*	0.045	**	0.073	**	0.055	**
	0.047		*0.006*		*0.005*		*0.004*	
$\Delta s_{(t-2)}$			0.0298	**			0.046	**
			0.005				*0.004*	
$\Delta s_{(t-3)}$			0.0179	**			0.038	**
			0.005				*0.004*	
$(k-s)_{(t-2)}$	-0.159	**			-0.216	**		
	0.022				*0.006*			
$s_{(t-2)}$	-0.062				-0.136	**		
	0.061				*0.006*			
uc(t)	-0.067	*			-0.145	**		
	0.027				*0.005*			
uc(t-1)	0.036				0.014	**		
	0.019				*0.004*			
uc(t-2)	0.002				0.002			
	0.017				*0.004*			
Δuc(t)			-0.124	**			-0.124	**
			0.037				*0.004*	
Δuc(t-1)			-0.06	*			-0.08	**
			0.03				*0.004*	
Δuc(t-2)			-0.036				-0.047	**
			0.026				*0.004*	
Δuc(t-3)			-0.007				-0.026	**
			0.0096				*0.003*	
Liq(t)/K(t-1)	0.064	*	0.11	**	0.008		0.025	**
	0.029		*0.032*		*0.006*		*0.006*	
Liq(t-1)/K(t-2)	-0.013	*	-0.011		0.015	*	0.032	**
	0.015		*0.018*		*0.005*		*0.006*	
Liq(t-2)/K(t-3)	-0.005		-0.006		0.007		0.014	*
	0.007		*0.007*		*0.005*		*0.006*	
Liq(t-3)/K(t-4)			0.006				0.028	**
			0.007				*0.006*	
m2	.944(p=0.345)		-668(p=0.504)		-1.169 (p=0.242)		-.225(p=0.822)	
Sargan test	97.3(p=.235)		104.9(p=.228)					
Total effect of sales	0.61		0.159	**	0.37	**	0.163	**
	(0.349)		*(0.051)*		*(0.021)*		*(0.009)*	
Total effect of user cost	-0.18		-0.28	**	-0.60	**	-0.23	**
	(0.204)		*(0.110)*		*(0.038)*		*(0.012)*	
Total effect of cash flow	0.29	*	0.12	**	0.14	**	0.08	**
	(0.130)		*(0.032)*		*(0.041)*		*(0.009)*	

Significance levels: **=1%, *=5%

I/K: investment over lagged capital at replacement value; *uc*: log of the user cost; *s*: log of sales; *Liq/K*: liquidity over capital; *k*: log of capital. *m2* is the test of second-order autocorrelation (p-value in parenthesis); *Sargan* is the test of overidentifying restrictions (p-value in parenthesis). (1) Instruments: I/K(t-2); (k-s)(t-4); Δs(t-2 to t-4); "apparent" interest rate (t-4); Liq/K (t-2 to t-4); control for time and industry dummies. (2) Instruments: I/K (t-2 to t-4); Δs(t-2 to t-4); Δuc(t-4); Liq/K (t-2 to t-4); control for time dummies.

Table 7

Alternative specification: manufacturing firms

Dependent variable: I(t)/K(t-1)
Sample: 1989-1999 - 7026 firms - 43912 obs.

	ADL (1)		ECM (2)	
	other firms	dummy for manufacturing	other firms	dummy for manufacturing
$I_{(t-1)}/K_{(t-2)}$	0.137 **	-0.011	-0.041	-0.026
	(0.046)	*(0.055)*	*(0.036)*	*(0.043)*
$I_{(t-2)}/K_{(t-3)}$	0.021	-0.031		
	(0.066)	*(0.037)*		
$I_{(t-3)}/K_{(t-4)}$	-0.006	0.001		
	(0.021)	*(0.003)*		
$\Delta s_{(t)}$	0.018	-0.018	0.000	0.037
	(0.041)	*(0.058)*	*(0.031)*	*(0.044)*
$\Delta s_{(t-1)}$	0.024	0.021	-0.006	0.026
	(0.014)	*(0.019)*	*(0.034)*	*(0.035)*
$\Delta s_{(t-2)}$	0.018	0.014		
	(0.013)	*(0.018)*		
$\Delta s_{(t-3)}$	0.015	-0.004		
	(0.009)	*(0.012)*		
$(k-s)_{(t-2)}$			-0.143 **	-0.056
			(0.037)	*(0.043)*
$s_{(t-2)}$			-0.152 **	-0.0107
			(0.036)	*(0.015)*
uc(t)			-0.103 *	0.006
			(0.041)	*(0.050)*
uc(t-1)			0.029	0.003
			(0.033)	*(0.037)*
uc(t-2)			0.003	-0.006
			(0.035)	*(0.041)*
Δuc(t)	-0.152 *	-0.004		
	(0.075)	*(0.083)*		
Δuc(t-1)	-0.081	-0.007		
	(0.050)	*(0.006)*		
Δuc(t-2)	-0.054	0.005		
	(0.042)	*(0.047)*		
Δuc(t-3)	-0.020	0.000		
	(0.016)	*(0.018)*		
CF(t)/K(t-1)	0.199 **	-0.021	0.063	-0.011
	(0.053)	*(0.076)*	*(0.042)*	*(0.049)*
CF(t-1)/K(t-2)	-0.015	0.044	0.107 **	-0.053
	(0.054)	*(0.070)*	*(0.040)*	*(0.055)*
CF(t-2)/K(t-3)	-0.031	0.047	-0.032	-0.047
	(0.055)	*(0.079)*	*(0.033)*	*(0.044)*
CF(t-3)/K(t-4)	0.057	0.007		
	(0.064)	*(0.077)*		
m_2	0,093(p=,926)		1,3(p=,196)	
Sargan test	180,0(p=,029)		207,5(p=,123)	

	other firms(a)	manufacturing(b)	other firms(a)	manufacturing(b)
Total effect of sales	0.088	0.099	-0.063	0.182
	(0.062)		*(0.102)*	
(b)-(a)	0.011		0.245	
	(0.087)		*(0.353)*	
Total effect of the user cost	-0.362 *	-0.352	-0.497	-0.342
	(0.191)		*(0.485)*	
(b)-(a)	0.010		0.155	
	(0.213)		*(0.533)*	
Total effect of cash flow	0.248 *	0.323	0.965	0.136
	(0.127)		(0.571)	
(b)-(a)	0.075		-0.829	
	(0.213)		*(0.591)*	

Significance levels: **=1%, *=5%

I/K: investment over lagged capital at replacement value; *uc*: log of the user cost; *s*: log of sales; *CF/K*: cash flow over capital; *k*: log of capital. *m2* is the test of second-order autocorrelation (p-value in parenthesis); *Sargan* is the test of overidentifying restrictions (p-value in parenthesis). (1) GMM estimation. Instruments: I/K(t-2 to t-4); Δs(t-2 to t-4); Δuc (t-4); CF/K (t-2); control for time dummies. (2) GMM estimation. Instruments: I/K (t-2); Δs(t-2 to t-6); (k-s)(t-4); “apparent” interest rate (t-4); CF/K (t-4 to t-5); control for time dummies.

Table 8

Groups of firms

(number of observations)

	with high share of intangible assets (2)	with low share of intangible assets	total
small (1)	22834	16687	39521
large	1756	2635	4391
total	24591	19321	43912

	paying dividend (3)	not paying dividend	total
small (1)	505	39016	39521
large	329	4062	4391
total	834	43078	43912

	with high share of intangible assets (2)	with low share of intangible assets	total
paying dividend (3)	378	456	834
not paying dividend	24213	18865	43078
total	24591	19321	43912

Number of observations falling into each group and falling simultaneously into two groups. (1) Firms with fewer than 200 employees. (2) Firms with a ratio of intangible assets (R&D expenses, patents, developing costs) to total assets higher than 75 per cent of the distribution in at least one year. (3) Firms with non-negative payout for the whole period.

Investment equation: differences among groups of firms

Dependent variable: I(t)/K(t-1)
Sample: 1989-1999 - 7026 firms - 43912 obs

	large firms	dummy for small firms	firms with low share of intangible assets	dummy for high share of intangible assets	firms not paying dividends	dummy for firms paying dividends
$I_{(t-1)}/K_{(t-2)}$	0.133 **	-0.043	0.117 **	-0.048	0.026 **	-0.520 **
	(0.028)	*(0.050)*	*(0.029)*	*(0.043)*	*(0.080)*	*(0.102)*
$I_{(t-2)}/K_{(t-3)}$	0.004	-0.049	-0.008	-0.036	-0.127 *	-0.480 **
	(0.019)	*(0.034)*	*(0.021)*	*(0.030)*	*(0.078)*	*(0.101)*
$I_{(t-3)}/K_{(t-4)}$	-0.016	-0.010	-0.012	-0.017	-0.043	-0.076
	(0.013)	*(0.024)*	*(0.018)*	*(0.024)*	*(0.088)*	*(0.120)*
$\Delta s_{(t)}$	-0.009	0.039	0.086 **	-0.033	0.009	0.036
	(0.034)	*(0.054)*	*(0.029)*	*(0.049)*	*(0.041)*	*(0.048)*
$\Delta s_{(t-1)}$	0.069 **	-0.016	0.056 **	0.013	0.043 **	0.036
	(0.013)	*(0.020)*	*(0.012)*	*(0.018)*	*(0.016)*	*(0.031)*
$\Delta s_{(t-2)}$	0.018	0.034	0.048 **	0.000	0.055 **	-0.036
	(0.013)	*(0.018)*	*(0.011)*	*(0.017)*	*(0.013)*	*(0.026)*
$\Delta s_{(t-3)}$	0.009	0.006	0.024 **	-0.019 *	0.027 **	0.006
	(0.008)	*(0.010)*	*(0.006)*	*(0.009)*	*(0.007)*	*(0.020)*
$\Delta uc(t)$	-0.125 **	-0.028	-0.124 **	0.010	-0.130 **	-0.077
	(0.027)	*(0.051)*	*(0.030)*	*(0.047)*	*(0.047)*	*(0.067)*
$\Delta uc(t-1)$	-0.060 **	-0.043	-0.063 *	-0.030	-0.091 *	-0.005
	(0.022)	*(0.044)*	*(0.028)*	*(0.039)*	*(0.041)*	*(0.065)*
$\Delta uc(t-2)$	-0.016	-0.089 *	-0.036	-0.053	-0.110 **	0.050
	(0.019)	*(0.041)*	*(0.026)*	*(0.038)*	*(0.041)*	*(0.072)*
$\Delta uc(t-3)$	0.002	-0.035 *	-0.003	-0.022	-0.036 **	-0.016
	(0.008)	*(0.015)*	*(0.010)*	*(0.015)*	*(0.014)*	*(0.027)*
CF(t)/K(t-1)	0.103 *	0.142 *	0.119 *	0.145 *	0.192 **	-0.006
	(0.047)	*(0.069)*	*(0.054)*	*(0.060)*	*(0.049)*	*(0.110)*
CF(t-1)/K(t-2)	0.047	-0.009	0.019	0.043	-0.059	0.146
	(0.029)	*(0.058)*	*(0.034)*	*(0.050)*	*(0.048)*	*(0.099)*
CF(t-2)/K(t-3)	0.055	-0.043	-0.030	0.099	-0.084	0.254
	(0.043)	*(0.068)*	*(0.001)*	*(0.065)*	*(0.053)*	*(0.130)*
CF(t-3)/K(t-4)	0.075	0.103	0.102	0.094	0.089	-0.072
	(0.043)	*(0.087)*	*(0.058)*	*(0.082)*	*(0.068)*	*(0.092)*
m2	.953 (p=0.341)		-0.127(p=.899)		-0.895(p=.371)	
Sargan test	177.9 (p=.037)		263.3(p=0.046)		65.9 (p=0.978)	

	(a) large	(b) small	(a) low int.	(b) high int.	(a) no div.	(b) div.
Total effect of sales	0.099	0.153	0.237 **	0.174	0.117 **	0.079
	(0.053)		*(0.046)*		*(0.045)*	
(b)-(a)		0.054		-0.063		-0.038
		(0.077)		*(0.067)*		*(0.055)*
Total effect of the user cost	-0.226 **	-0.402	-0.250 **	-0.320	-0.321 *	-0.187
	(0.076)		*(0.088)*		*(0.134)*	
(b)-(a)		-0.175		-0.069		0.134
		(0.134)		*(0.125)*		*(0.153)*
Total effect of the cash flow	0.319 **	0.482	0.233 *	0.589	0.121	0.207
	(0.116)		*(0.105)*		*(0.125)*	
(b)-(a)		0.164		0.356 *		0.087
		(0.185)		*(0.166)*		*(0.201)*

Standard errors in parentheses. Significance levels: **=1%, *=5%

I/K: investment over lagged capital at replacement value; *uc*: log of the user cost; *s*: log of sales; *CF/K*: cash flow over capital;. *m2* is the test of second-order autocorrelation (p-value in parenthesis); *Sargan* is the test of overidentifying restrictions (p-value in parenthesis). GMM estimation. Instruments: Δs(t-2 to t-4); Δuc (t-4); CF/K (t-2); control for time dummies (common to all regressions); I/K(t-2 to t-4) (for large/small); I/K(t-2 to t-9) (high/low intangibles); I/K(t-2) (dividends/no dividends).

Table 10

Robustness check: differences among groups of firms (ECM model)

Dependent variable: I(t)/K(t-1)
Sample: 1989-1999 - 7026 firms - 43912 observations

	large firms	dummy for small firms	firms with low share of intangible assets	dummy for high share of intangible assets	firms not paying dividends	dummy for firms paying dividends
$I_{(t-1)}/K_{(t-2)}$	-0.014	0.033	-0.086 *	0.081	-0.022	-0.193 **
	(0.024)	*(0.041)*	*(0.035)*	*(0.053)*	*(0.028)*	*(0.031)*
$\Delta s_{(t)}$	0.024	-0.027	0.057	-0.006	-0.003	-0.056
	(0.027)	*(0.043)*	*(0.034)*	*(0.054)*	*(0.033)*	*(0.034)*
$\Delta s_{(t-1)}$	0.041	-0.032	0.098 *	-0.014	0.018	-0.006 *
	(0.034)	*(0.046)*	*(0.038)*	*(0.062)*	*(0.035)*	*(0.038)*
$(k-s)_{(t-2)}$	-0.129 **	-0.058	-0.241 **	0.079	-0.155 **	-0.172 **
	(0.021)	*(0.039)*	*(0.033)*	*(0.058)*	*(0.027)*	*(0.030)*
$s_{(t-2)}$	-0.121 **	-0.041	-0.134 **	0.06	-0.131 **	-0.129 **
	(0.036)	*(0.057)*	*(0.051)*	*(0.077)*	*(0.043)*	*(0.046)*
uc(t)	-0.086 **	0.009	-0.071 *	-0.007	-0.079 **	-0.091 **
	(0.026)	*(0.039)*	*(0.033)*	*(0.054)*	*(0.028)*	*(0.029)*
uc(t-1)	0.027	-0.008	0.012	-0.012	0.022	0.137 **
	(0.022)	*(0.031)*	*(0.027)*	*(0.040)*	*(0.021)*	*(0.025)*
uc(t-2)	0.053	-0.071 **	-0.001	0.011	-0.010	0.085 **
	(0.019)	*(0.025)*	*(0.023)*	*(0.035)*	*(0.017)*	*(0.023)*
CF(t)/K(t-1)	-0.005	0.076 *	0.000	0.140 *	0.077 *	0.124 **
	(0.031)	*(0.040)*	*(0.053)*	*(0.060)*	*(0.031)*	*(0.039)*
CF(t-1)/K(t-2)	-0.024	0.1 **	-0.019	-0.014	0.066 *	-0.048
	(0.025)	*(0.041)*	*(0.034)*	*(0.049)*	*(0.032)*	*(0.037)*
CF(t-2)/K(t-3)	0.039 *	-0.11 **	-0.043 **	-0.009	-0.052	0.086 **
	(0.021)	*(0.035)*	*(0.031)*	*(0.048)*	*(0.028)*	*(0.031)*
m_2	1.4(p=.158)		1.8(p=.07)		1.28(p=.20)	
Sargan test	223.4(p=.087)		192.6(p=.063)		196.2(p=.272)	

	(a) large	(b) small	(a) low int.	(b) high int.	(a) no div.	(b) div.
Total effect of sales	0.062	0.134	0.444 **	0.543	0.155	0.205
	(0.251)		*(0.179)*		*(0.223)*	
(b)-(a)		0.072		0.099		0.050
		(0.332)		*(0.362)*		*(0.227)*
Total effect of the user cost	-0.047	-0.406	-0.248	-0.418	-0.430 *	0.197
	(0.334)		*(0.182)*		*(0.220)*	
(b)-(a)		-0.360		-0.170		0.627 **
		(0.385)		*(0.398)*		*(0.230)*
Total effect of the cash flow	0.078	0.406	-0.259	0.337	0.587	0.774
	(0.227)		*(0.275)*		*(0.354)*	
(b)-(a)		0.329		0.596		0.187
		(0.373)		*(0.694)*		*(0.368)*

Standard errors in parentheses. Significance levels: **=1%, *=5%

I/K: investment over lagged capital at replacement value; *uc*: log of the user cost; *s*: log of sales; *CF/K*: cash flow over capital;. *m2* is the test of second-order autocorrelation (p-value in parenthesis); *Sargan* is the test of overidentifying restrictions (p-value in parenthesis). GMM estimation. Instruments: I/K(t-2); (k-s)(t-4); Δs(t-2 to t-6); “apparent” interest rate (t-4); CF/K (t-4 to t-5) (CF/K(t-2) for high/low intangibles); control for time dummies.

Table 11

The effects of monetary policy on the stock of capital, by groups of firms

A - Effect of a temporary increase in policy rates on investment determinants (1)

(percent)

	Resulting change in: User cost	Value added	Cash Flow/K
	3.2%	-0.7%	-3.4%

B - Effect of investment determinants on the stock of capital (2)

(percentage points)

	Effect of a 1% change in : User cost	Sales growth	Cash flow/K
All firms	-0.24	0.11	0.11
Large	-0.23	0.09	0.06
Small	-0.38	0.14	0.11
Low share of intangibles	-0.24	0.21	0.05
High share of intangibles	-0.31	0.18	0.13

C - Effect of a temporary increase in policy rates on the stock of capital (3)

(percentage points)

	Total effect	Effect due to: User cost	Sales growth	Cash Flow/K
All firms	-0.90	-0.59	-0.05	-0.26
Large	-0.75	-0.54	-0.04	-0.17
Small	-1.29	-0.95	-0.07	-0.27
Low share of intangibles	-0.82	-0.59	-0.11	-0.12
High share of intangibles	-1.20	-0.78	-0.09	-0.33

(1) Effect of a one percentage point increase in policy rates after two years. Simulation of the quarterly model of the Italian economy. (2) Cumulated effect on *I/K* of a permanent unit increase in the log of the user cost and sales and a permanent increase in *CF/K* equal to its sample mean. Simulation of the ADL investment equations in tables 6 and 10. (3) Cumulated effect on *I/K* after three years of a temporary (two-year) one percentage point increase in policy rates. Joint simulation of the macro equations and of the micro investment equations.

Table 12

The effects of monetary policy on investment, by groups of firms

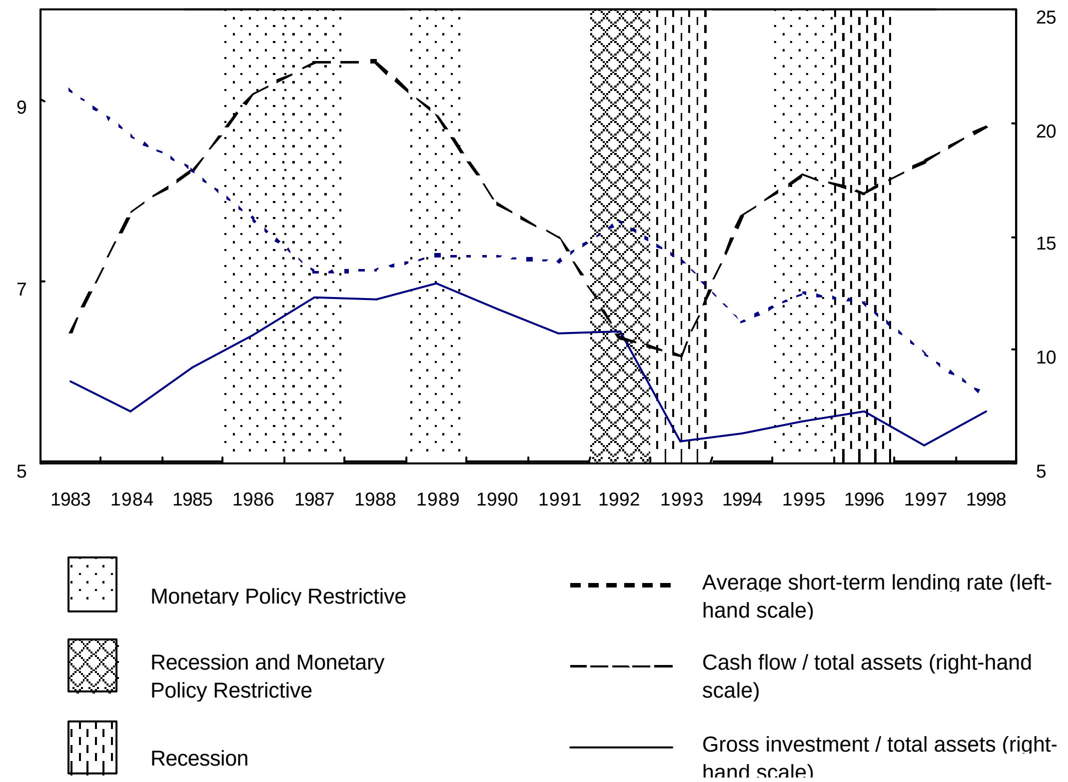
(percentage deviation from baseline)

	All	Large	Small	Low share of intangibles	High share of intangibles
first year	-3.7	-3.5	-4.9	-3.8	-4.0
second year	-3.9	-3.4	-5.3	-3.7	-5.0

Effect of a one percentage point increase in policy rates, sustained for two years. The effect on investment is approximated by dividing the effect on I/K for each year (obtained from the simulation underlying Table 11) by the average I/K ratio (see Appendix).

Figure 1

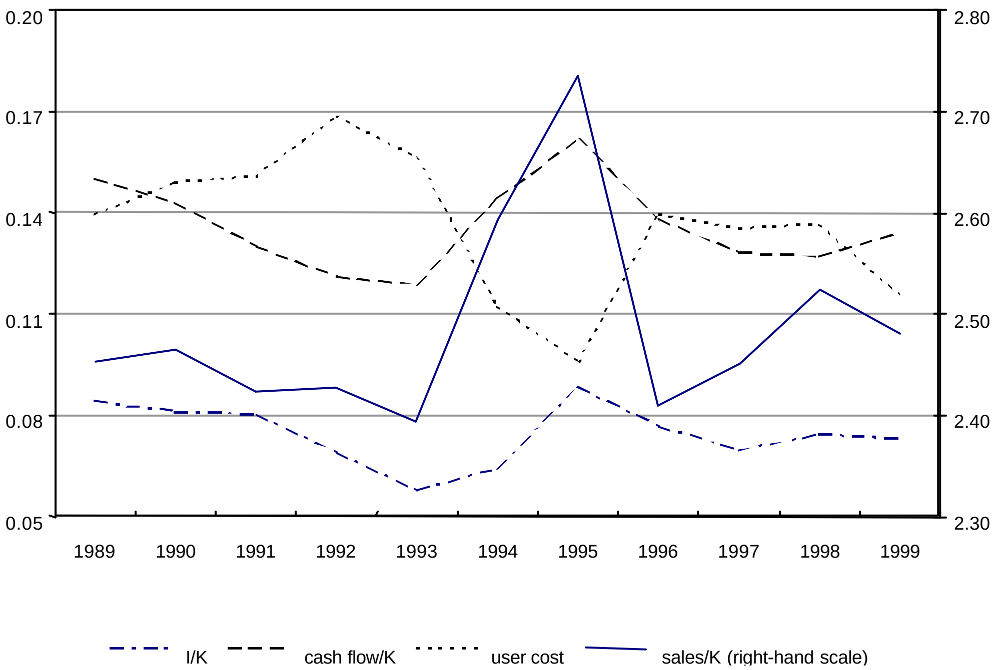
Investment, cash flow and monetary restrictions



Source: Company Accounts Data Service (*Centrale dei Bilanci*). Averages, weighted with total assets.

Figure 2

The main variables



Source: Company Accounts Data Service (*Centrale dei Bilanci*). Median value in each year of the variables in the sample used in the regression.

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