How Interest Sensitive is Investment? Very (when the data are well measured)[#]

Luigi Guiso
Università di Sassari, Ente Luigi Einaudi for Monetary, Banking, and Financial Studies, and Center for Economic Policy Research

Anil K Kashyap
University of Chicago, Graduate School of Business, Federal Reserve Bank of Chicago, and National Bureau of Economic Research

Fabio Panetta
Research Department, Bank of Italy

Daniele Terlizzese
Research Department, Bank of Italy

This draft: July 29, 2002
First draft: December 31, 2001

Abstract

We use a unique data set covering over 30,000 Italian firms over 10 years to estimate the interest sensitivity of investment. This data set has three special attributes. First, it includes information that allows us to link firms to the banks from which they are borrowing. Second, the terms of the lending agreements are quite accurately recorded. Finally, we have balance sheet and other cost information about the banks. Together these features allow us determine a marginal financing cost for firms and to identify fluctuations in these costs that are supply driven (and hence uncorrelated with investment demand). We exploit this supply induced variation in interest rates to estimate the interest sensitivity of investment. Our results show that: *i*) when ignoring endogeneity problems, the user cost of capital is estimated to have a negative effect on investment decisions but the effect is tiny and similar in magnitude to what is found in typical estimates using aggregate time series data; ii) once endogeneity is properly accounted for, the estimated effects are about 10 time larger. The elasticity of capital with respect to the user cost of capital is found to be about -1.

JEL codes: E22, E00, G31
Keywords: investment, user cost of capital, interest rates

[#] Kashyap thanks the Stigler Center at the University of Chicago Graduate School of Business, Houblon Norman Fund, and the National Science Foundation for a grant through the National Bureau of Economic Research for research support. Luigi Guiso acknowledges financial support from MURST and the European Commission, under the RTN project "Specialization Versus Diversification: The Microeconomics of Regional Development and The Spatial Propagation of Macroeconomic Shocks in Europe". We thank Steve Bond, Robert Chirinko, Simon Gilchrist and Charles Himmelberg for useful discussions and seminar participants at the NBER workshop on Capital Markets and the Economy for comments. The views in this paper are only those of the authors and are not necessarily endorsed by the Bank of Italy, the Federal Reserve Bank of Chicago, or the Federal Reserve System.

Introduction

The workhorse model for monetary policy analysis is a system of 3 equations that are typically described as dynamic IS curve, an aggregates supply (or Phillips Curve) and Central Bank reaction equation.[1] This model has become predominant for several reasons. One is that it appears to adequately describe inflation and output dynamics in most countries. Another is that it has clear microeconomic foundations.[2] This means that the equations can be derived as a set of optimal responses and the parameters interpreted accordingly. A third advantage is its simplicity makes it easy to use to study a range of questions.

The pervasiveness of this model makes it all the more important to establish reliable estimates of the parameters that will be used when implementing it in practice. Large bodies of work have analyzed the stability of the Phillips curve and properties of alternative central bank reaction functions. Yet, there is surprisingly little work on estimating the parameters of the IS curve.[3]

Indeed, conventional wisdom about the IS curve is a bit schizophrenic. On the one hand, most textbooks (and instructors) state that aggregate demand is interest sensitive. Yet, the relevant empirical estimates mostly suggest otherwise. For instance, there is a large literature, starting with Hall (1988), demonstrating that the interest sensitivity of consumption is low.[4] Similarly, pinning down the interest sensitivity of investment is notoriously hard. As Blanchard (1986, p 153) put it, “it is well known that to get the user cost to appear at all in the investment equation, one has to display more than the usual amount of econometric ingenuity.”

In this paper we take up Blanchard’s challenge to see if a unique microeconomic data set yields more precise estimates of the interest sensitivity of investment (that we will sometimes refer to

---

[1] For a derivation and discussion of the model’s properties see Clarida, Gali, and Gertler (1999).

[2] See Woodford (2002) for one such derivation.

[3] Prominent exceptions are Rotemberg and Woodford (1999) and Rudebusch and Svensson (1999). More recent and ambitious specifications can be found in Christiano et al (2001) and Smets and Wouters (2002).

as the slope of the IS curve)[5]. This data set covers over 30,000 Italian firms for 10 years and has three important attributes. First, it includes information that allows us to link firms to their banks. Second, the terms of the lending agreements are known. Finally, we have balance sheet and other cost information about the banks. Together these features allow us determine a marginal financing cost for firms and to identify fluctuations in these costs that are loan supply driven. We exploit this supply induced variation in interest rates to estimate the slope of the IS curve.

Using these data we find, as in many other studies, standard estimation methods yield negative but tiny estimates of the interest sensitivity of investment. But once we properly account for the simultaneous nature of the borrowing and investment decision, that investment is estimated to be roughly ten times more sensitive to interest rates. Our baseline estimates suggest that the elasticity of capital with respect to the user cost of capital is very close to one; the value that would be implied by the Cobb-Douglas production function. However, we also find that the data reject the assumption of constant returns to scale.

The remainder of the paper is organized into 7 sections. We begin with a brief review of the literature, focusing on the general findings and the standard explanations for these results. The next section lays out a model that relates firms' investment to the borrowing terms offered by banks. Section 4 describes the general features of our data set, while the following describes our estimating equation and shows how it fits for aggregate data. The fifth section shows our estimates of the slope of the IS curve using firm-level data. The penultimate section shows a number of cross-checks that we conducted to assess the robustness of these findings. Our conclusions and suggestions for future work are given in the final section.

---

4 This is not necessarily puzzling since if consumers have time separable preferences that are logarithmic in consumption the income and substitution effects of interest rates would be predicted to exactly cancel.

2. Past Literature on the Interest Sensitivity of Investment

Chrinko, Fazzari and Meyer (2001) offer an excellent, up to date review of the empirical work seeking to estimate the elasticity of capital formation with respect to the user cost of capital. They make two broad points. First, that there is little consensus over value of the elasticity, with published estimates ranging from zero to negative two. Second, the econometric challenges differ depending on whether one uses firm-level data or aggregate time series.

2.1 Aggregate Time Series Estimates

For the time series studies we believe the biggest problem is finding a way to overcome simultaneity bias that arises because central banks often raise interest rates when they believe invest demand is rising. This fact induces positive correlation between investment and interest rates, and will lead to a downward bias in estimates of the user cost elasticity.

The only way to overcome it is to find and exploit other variation in the investment supply curve in the estimation effort. This is difficult. The user cost of capital depends on four factors: depreciation, taxes, the relative price of capital to output, and financing costs. The three non-interest components do not tend to have much cyclical variation.

To the extent there is much time variation in the non-interest components of the user cost, it is likely due to tax changes. But analyzing tax-induced variation brings several other problems. First, because many tax changes (e.g variation in investment tax credits) are expected to be transitory, inferring the effects can be complicated. On the one hand, firms may move forward already planned investment in order to capture the tax subsidy. This would lead one to over-estimate the response. On the other hand, if the subsidy is too short-lived and there are high costs of adjusting the capital stock, then firms' responses will be dampened. This would lead to an under-estimate.

[5] In fact, the slope of the IS curve depends on a number of other elasticities, notably the elasticity of consumption with respect to output. See Angeloni et al (2002) for further discussion.

Furthermore, as Goolsbee (1998) notes, since tax changes are usually across the board, it is also possible that the suppliers of capital goods will raise prices to capture some of the tax gains. If this is the case, it can also lead to lower estimates of the user cost elasticity than the true demand elasticity.

Perhaps because of these difficulties there have been relatively few recent attempts to use aggregate time series to infer the slope of the IS curve. Indeed, the only study within the last five years cited by Chrinko, Fazzari and Meyer (2001) is one by the Joint Committee on Taxation (1997) comparing nine different tax models. These estimates (shown in their Table 6) range from -0.20 to -1.0. We concur with the Chrinko, Fazzari and Meyer that the time series evidence therefore provides very little guidance about the sensitivity of investment to interest rates.[6]

2.2 Disaggregated Estimates

There is much more recent work using dis-aggregated data to analyze the connection between investment and the user cost. Almost all the recent papers motivate the use of firm-level (or industry level) data as offering hope of finding more variation in the investment supply curve than can be found in macro data. Some also point out that heterogeneity can be better accounted for with these data. For instance, if investment is irreversible, and some firms in the sample are at a point where they would like to dis-invest but cannot, then estimates of the user cost elasticity will be biased towards zero. The intuition is simple: if some firms are hitting the irreversibility constraint, they will be within an inaction region where zero investment is optimal. For these firms, small changes in the interest rate will leave investment unaffected and only very large drops will trigger investment. For firms that are not in the inaction region (the "active" firms), small changes in the interest rate will have the usual impact. Thus, ignoring the difference in behavior between the two groups will lead to an average response of

[6] Recent work that focuses on the relation between capital demand and the user cost by Caballero (1994) and others seems more promising. This work concentrates on long run correlations and thus does not rely on correctly specifying adjustment costs. But for policy analysis exercises one must model investment not capital.

investment to the rate of interest that is smaller than the response among the active firms (see Caballero 1999 for a discussion of this).

Alternatively, if some firms are liquidity constrained, then this can also lead to biased estimates of the user cost elasticity. The direction of the bias, however, is ambiguous. To see why, consider the effect of an increase in interest rates. For conventional reasons this raises the cost of capital and should generate a decrease in investment. The higher rates will also reduce current profits and cash flow, and these decreases could amplify the investment decline for some constrained firms and lead to an over-estimate of the elasticity.[7] But suppose instead that a firm is already at a corner, whereby its lenders are rationing it. In this case, the change in rates may have no effect on the supply of borrowed funds and the estimated elasticity would be lower than for the non-rationed firms.

Without knowing the exact form of the credit market constraint one cannot tell which way the bias would go. But if one has firm level data, then these problems can be side-stepped by focusing on firms for which liquidity constraints are unlikely to matter. We pursue this strategy below and check that our results are not affected by composition effects; this is one of the things that distinguishes our paper from past work.

The prior papers in this literature generally fall into two groups. One set well represented by Cummins, Hassett, and Hubbard (1994, 1996) argues that accounting for measurement error in fundamentals (particularly q and the user cost) is the main challenge in working with micro data. Consequently they suggest searching for experiments that raise the signal to noise ratio in the fundamentals. In particular, they point to tax reforms as times when the variation in the user cost or q is high and not due to measurement error. Importantly, these tax reforms create considerable cross-sectional variation in firm's cost of capital; changes in depreciation allowances and the investment tax credit differentially affect firms.

Cummins, Hasset and Hubbard (1994) present regressions showing that around the tax reform periods the response of investment to the cost of capital is higher than at other times: their user cost elasticity estimates range from between -½ and -1. Goolsbee (2000) also suggests that controlling for measurement error is quite important. His estimate of the elasticity of investment with respect to tax changes is about –0.4 once measurement error is properly accounted for.

For the purposes of monetary policy analysis it is unclear whether the findings regarding tax-induced variation is a relevant benchmark. Monetary policy changes induce (at best) temporary changes in short term real interest rates. The interest rates embedded in the cost of capital is a longer term interest rate, although the details of exactly how this rate is determined vary across studies. Thus, it is not clear that responses to monetary induced shifts would approach those related to tax changes.

Indeed, the studies that do not exclusively focus on tax shifts find substantially lower elasticities. For instance, Chirinko, Fazzari, and Meyer (2001) study a large US panel data set and obtain a set of estimates that cluster around –0.25 Chatelain et al (2001) also find estimates for large panels of firms from France, Italy, Germany and Spain: their long-run elasticity estimates lie between -0.1 for France to –0.65 for Germany. Their estimate for Italy is -0.11, but with slight changes to the instrument set rises to -0.23 and appears to be in line with the estimate of -0.2 to -0.3 of Gaiotti and Generale (2001).

Overall, we read the micro economic evidence as saying that the user cost elasticity is larger than estimates typically recovered from aggregate time series. However, there is still considerable disagreement over the size of the elasticity. Moreover, there is little agreement over which of the many potential econometric problems is most serious.

3. Modeling simultaneous investment and borrowing decisions

---

[7] As Chirinko , Fazzari, and Meyer (1999) footnote 17 point out there can also be interactions with the tax code through tax loss carry forwards that can reinforce these effects.

In this section we provide a simple theoretical framework to clarify the biases that can emerge when estimating an investment function using firm-level data. The model also helps identify candidate instruments that can be used to obtain consistent estimates of the interest rate elasticity.

Consider firms that are endowed with either of 2 projects, a "good" one or a "bad" one, that we label g and b respectively. For simplicity we assume that the firm starts with no internal funds and can only finance the project by taking a loan from a bank. For a given loan (and hence project) size, the distribution of the good and the bad projects are:

$$y^g \begin{cases} = y_h, & \text{with probability } p_h \\ = y, & \text{with probability } p \\ = 0, & \text{with probability } 1-p-p_h \end{cases} \quad ; \quad y^b \begin{cases} = y, & \text{with probability } q \\ = 0, & \text{with probability } 1-q \end{cases}$$

The realizations are a function of the amount of the loan l. In particular, $y_h = a_h l^{\alpha}$ and $y = al^{\alpha}$, with $a_h > a$. We make the natural assumption that the good project has higher expected return, but is also riskier. This requires $a_h p_h + ap > aq$ and $p_h + p < q$.

To simplify the matching between borrowers and lenders we assume that each firm can only borrow from one bank that has local monopoly power. While this is an extreme assumption it captures the idea that credit markets are geographically segmented especially for relatively small borrowers, implying that lenders have monopoly power with respect to their clients. The monopoly power could also be motivated by the informational capture considerations described by Sharpe (1991) and Rajan (1992). Our assumption is also consistent with empirical evidence that documents the importance of distance in the provision of bank credit to small firms (Petersen and Rajan, 2000) and the relevance of local financial development for firms performance (Guiso, Sapienza and Zingales, 2001; Jayaratne and Strahan, 1996).

The bank i has (unitary) financing costs γ_i, observes the firm's project type, and maximizes its expected profits subject to loan demand. Let R_i^g and R_i^b denote the (gross) interest rates charged by bank i to a firm with a good and bad project, respectively. Assuming that the interest payment is smaller than the worst positive realization of the project, i.e. that $R^g l^g < a(l^g)^\alpha$ and $R^b l^b < a(l^b)^\alpha$ (these will be translated into parametric restriction later on), it is easy to show that the demand for loan of a firm borrowing from bank i, is:

$$l_i^g = \left(\frac{a_h p_h + ap}{p_h + p}\alpha\right)^{\frac{1}{1-\alpha}} (R_i^g)^{-\frac{1}{1-\alpha}}$$

if the firm has the good project, or:

$$l_i^b = (a\alpha)^{\frac{1}{1-\alpha}} (R_i^b)^{-\frac{1}{1-\alpha}}$$

if the firm has the bad project.

Notice that the terms $\frac{a_h p_h + ap}{p_h + p}$ in the good firm's loan demand and a in the bad firm's demand function, represent the expected output from one dollar invested in the good and bad project, respectively, conditional on the project being successful. These terms are firm-specific and are typically not observed by the econometrician. As we will discuss below, the inability to properly account for these unobservable terms can bias the estimates of the interest rate elasticity when using microeconomic data. Also notice that, for a given level of the interest rate, the loan demand from a firm with a good project is larger than the loan demand from a firm with a bad project, since $\frac{a_h p_h + ap}{p_h + p} > \frac{aq}{p_h + p} > \frac{aq}{q}$.

Using the loan demand and solving the profit maximization problem of the monopolist bank the interest rates charged by the bank i will then be:

$$R_i^g = \frac{\gamma_i}{\alpha(p_h + p)} \qquad \text{(for the good project)}$$

$$R_i^b = \frac{\gamma_i}{\alpha q} \qquad \text{(for the bad project)}$$

Given these findings, we can spell out the parametric restriction that needs to be satisfied for the interest payment to be feasible: $a(p_h + p) > \alpha(a_h p_h + ap)$. This will be assumed throughout.

Importantly, the rate charged on the good project exceeds that on the bad one ($R_i^g > R_i^b$) because of our assumption that the good project is riskier than the bad one. Given that the firm has no alternative source of financing, the loan demand can also be interpreted as investment demand. Substituting the expression for the interest rate into the loan demand we see that the "good firm" has higher investment:

$$l_i^g = \left(\frac{a_h p_h + ap}{\gamma_i}\alpha^2\right)^{\frac{1}{1-\alpha}} > \left(\frac{aq}{\gamma_i}\alpha^2\right)^{\frac{1}{1-\alpha}} = l_i^b$$

We can therefore see the nature of the bias that can emerge in firm-level estimates of the investment equation: "better" firms invest more but also pay higher interest. If firm quality – i.e. its investment opportunities – is not observed by the econometrician, or is only imperfectly observed, but is observed by the bank, estimates of the interest rate elasticity will be biased towards zero. This is the analogous bias to the one that plagues macroeconomic data.

An alternative way to look at the problem is to imagine an econometrician that only observes the amount invested and the rate paid. He will estimate:

$$\log(l_{ij}) = \beta_0 + \beta_1 \log(R_{ij}) + u_j$$

where j indexes the firms in the sample. Clearly, the true value of β_1 is $-\frac{1}{1-\alpha}$. However, for the good firms u_j contains the term $\frac{1}{1-\alpha}\log(\frac{a_h p_h + ap}{p_h + p}\alpha)$ while (the log of) the interest rate is $\log(\frac{\gamma_i}{\alpha(p_h + p)})$; for the bad firms u_j contains the term $\frac{1}{1-\alpha}\log(aq/q)$ and (the log of) the interest rate is $\log(\frac{\gamma_i}{\alpha q})$. Hence, u_j is higher when the interest rate is higher, and this implies a bias towards zero of the estimate of β_1.[8]

This same prediction would follow provided that firms face an upward sloping supply for loans. Models with contracting imperfections will deliver this implication. Ceteris paribus, firms with better investment opportunities will have larger investment plans and will thus need more external finance, and end up paying higher interest rates. If this endogeneity is ignored, then ordinary least squares estimation will produce estimates that are biased towards zero.[9]

Whatever the mechanism giving rise to bias, the model suggests a natural set of instruments to resolve the simultaneity problem: a good instrument for R_i is γ_i, as it is correlated with R_i but not with u_j. This implies that any bank characteristic that affects the cost of a banks' external finance or its efficiency in intermediating funds,[10] is a valid instrument. We rely on this intuition about the importance of finding supply-induced variation in the cost of funds in selecting our instruments.

8 Of course, the bias could go in the other direction and overstate the negative effect of the interest rate on investment if high-yield firms are charged lower interest rates, i.e. if firms with high expected return projects have a lower probability of default.

9 There is one testable implication that can be exploited with firm-level data: firms facing a steeper supply for loans should show a more severe bias when investment equations are estimated with OLS. Firms with a steeper supply for loans are typically those with more severe contracting problems, i.e. small businesses and firms that cannot easily substitute either across types of external finance and between banks. If this is the case, one can rely on sample splits to check whether the endogeneity bias is more severe for certain groups of firms. In other words, the extent of the bias across groups of firms can reveal information about the slope of the loans supply curve.

10 The parameter γ_i, broadly interpreted, includes the cost of deposits, the cost of any other source of funds as well as the administrative costs associated with the lending activity. Thus, more efficient banks will have a lower value of γ_i.

4. Data Description

4.1 Firm Characteristics

Our empirical work draws on three underlying sources of data. The first is the *Centrale dei Bilanci* (CB), which provides standardized data on the balance sheets and income statements of about 30,000 Italian non-financial firms, non-agricultural firms. This information, available since 1982, is collected by a consortium of banks interested in pooling information about their clients. A firm is included in the sample if it borrows from at least one of the banks in the consortium. The database is highly representative of the Italian non-financial sector: a report (Centrale dei Bilanci (1992)), based on a sample of 12,528 companies drawn from the database (including only the companies continuously present in 1982-90 and with sales in excess of 1 billion Lire in 1990), states that this sample covers 57 percent of the sales reported in the national income and product accounts.

The main difference between the CB and other widely analysed firm level data sets such as Compustat is the coverage of unlisted companies. In particular, this dataset mainly contains small (defined as less than 50 employees) and medium (between 50 and 250) firms that are privately owned; Moreover, 75 percent of the firms in the sample has less than 67 employees and 96 percent less than 275. It is important to stress this feature of the data in order to understand the power of our identification strategy, which relies on the characteristics of the banks from which the firm is borrowing to identify shifts in the supply of loans. This procedure will be highly effective when the bank enjoys some monopoly power over the firm or, equivalently, when the firm cannot switch lending relation costlessly. And this is more likely to be the case for small businesses, which can only borrow locally.

Table 1 reports summary statistics regarding firms' investment and sales performance for three representative years (1992, 1996 and 1998). The top panel shows data on the full set of firms in the CB, while the bottom reports information on the set of firms for which interest rate information on their borrowing is available. (The source of the interest rates and the procedure by which the matching occurs is described below.)

Focusing for now on the statistics for the full sample, the table highlights three main points about the data. First, it quantifies the heterogeneity regarding firm size. The median firm even at the end of the sample (i.e. in 1998) had sales of only 19 billion Lire, roughly $10 million at the exchange rate at that time. Second, the table also (indirectly) shows the business cycle variation that occurred during our sample period: the 1996 slowdown is reflected in the relatively low sales growth figures for that year. Finally, the table also shows that during each of the years there was tremendous variability in firms' investment patterns: the cross-sectional standard deviation of investment was over 15% in each of the years. This variation is one of the factors that helps us identify the slope of the IS curve. Appendix A1 describes these data in greater detail.

4.2 Interest Rates and the User Cost of Capital

We merge this firm level data with detailed information on their bank financing arrangements. The source of this information is the Italian Credit Register (Centrale dei Rischi). This is a database housed at the Bank of Italy that contains comprehensive information on loans contracts extended by all Italian banks. Banks must report to the Credit Register firm-specific data on the amounts granted and effectively utilized for all loans in excess of a minimum threshold: the threshold was 80 million lire (about $57,143 at an exchange rate of 1400 Lire/dollar) until December 1995 and 150 million lire thereafter. This information is reported separately for 6 different types of loans (financial and commercial paper, foreign credit operations, credit lines, collateralized loans, medium and long term loans and personal guarantees). For each of these loan categories, a subset of about 80 banks also report the interest rate they charge to individual borrowers on each type of loan. Reporting banks are on average relatively large and cover more than 80% of the Italian credit market.

Comparing the top and bottom panels of Table 1 it is apparent that the main consequence of concentrating on this subset of the CB sample is to select slightly larger firms. In particular, the investment rates of the full sample and the sample for which interest rate data are available are virtually identical. But the median level of sales is higher for the firms that borrow from these larger banks; the standard deviation of sales is also slightly lower. However, we do not believe these differences are important enough to warrant adjusting the results for this selection effect.

Most Italian companies – even relatively small ones – borrow from multiple banks (see Detragiache, Garella and Guiso, 2000), so even though not all banks report interest rate data we have some information on loan rates for most firms. For instance, among the firms included in the sample described in the bottom portion of Table 1, the firms in our sample (in 1995, a typical year) borrow on average from 6 banks and more than 75% of the firms have at least 4 lenders. So even with the incomplete interest rate information we still have several indicators to choose from.[11]

In principle, we are trying to identify the marginal financing rate. This leads us to focus on the rates reported on credit lines (rather than loans that have already been made) since they should reflect a rate at which a firm could actually secure more financing.[12] Since almost all firms have some credit lines this is also not limiting empirically. But even among credit lines there are several possible rates, so we consider several proxies.

[11] In future drafts of the paper we will explore whether the results we report below vary depending on the degree of potential mis-measurement of the interest rates. Specifically, we can further reduce the sample to include only firms that do the vast majority of their borrowing from the rate reporting banks (for these firms we can be confident that the rates that are measured are likely to come from the marginal lender). However, this modification should have minor effects on our results: in our sample the credit lines granted by banks that report also the interest rate represent more than 90% of the total (the median is equal to 1).

[12] Past rates are unlikely to be a good proxy for the marginal cost of funding since they may reflect collateral that is already pledged (as in the case of mortgages) or may have been granted by banks that are not willing to provide additional funds.

One alternative is the highest rate on any line that has been drawn upon. This is appropriate if we assume that the only reason for tapping this line is because it was that all was available. However, there is no guarantee that the firm can continue to borrow at this rate (or would again if new lines have been subsequently negotiated).

We believe a better alternative is the interest rate on the credit line with the largest untapped capacity (i.e. the one with the largest difference between credit granted and utilized). The main advantage of this measure compared to others is that we are certain that the firm can borrow at this rate. Presumably the large unused capacity reflects the fact firm was able to find cheaper financing for its previous projects. But looking forward this credit line would be the one to be used for new large projects. Accordingly we use this as the benchmark rate.

To cross-check these first two indicators we also consider a third proxy that we expect to be a poor approximation to the marginal borrowing rate. We do this because although it may be hard to discriminate among several reasonable proxies, there are rates on some credit lines that we strongly suspect should not approximate the marginal borrowing cost. One possibility is represented by the rate on credit lines that are already exhausted. To approximate this measure of a non-marginal rate, we compute for all firms the rate on the credit line that has the smallest unused balance. In 47% of the cases, these credit lines exhibit an overdraft (which means that the firm has obtained more credit than it was contractually guaranteed when the line was opened); thus, the median amount of credit available is very small (9 million lire, or $4,500), and the average firm exhibits an overdraft of 16 million lire. This suggests that these credit lines are unlikely to be relevant for future investment decisions.

The top panel of Table 2 shows summary statistics for these three interest rate proxies for the years 1992, 1996 and 1998. Leaving aside the details of the different proxies, two general features are immediately apparent. First, there is considerable cross-sectional variation with a standard deviation comprised between 300 and 600 basis points depending on the year and the interest rate measure chosen. Second, there is even more striking variation over time in these indicators, on the order of 1000 basis points between 1992 and 1998, independently of the interest rate proxy used.

The top portion of the table also contains information on measures of the user cost of capital constructed using each of our three measures of the interest rate. The user cost is constructed in the standard way, following Gaiotti and Generale (2001); their procedure is briefly described in appendix A2. Our paper has two novel aspects. The first is that we construct the user cost by using firm-specific interest rates, rather then a single interest rate equal for all firms. The second is the correction for the tax credit that was made available to Italian firms from 1994 to 1996 through the so called “Tremonti law”. This law offered a tax credit (equal to 50% of their capital expenditures) to firms that invested at a higher rate than they had averaged for the previous five years. This means that any ex-post measure of the user cost will be lower for the high-investment firms, thus generating an artificially strong negative correlation between investment and the user cost. In order to purge this spurious effect from our estimates we construct two measures of the user cost: one including the effects of the Tremonti law, and one ignoring the tax credits granted by the law. The latter (appropriately lagged) is then used in our IV estimates (when we do not use our preferred bank instruments) to instrument the cost of capital. This will be further discussed below, when we discuss our instrument selection.

For now the main point is that there is still a 600 basis point decline in the user cost estimates between 1992 and 1998, and substantial cross-sectional variation. This is impressive since the relative price terms and tax parameters are essentially the same in each of the three user cost measures; the substantial overlap in the non-interest rate components of the user cost explains why there is some compression in the variability (compared to the variation in interest rates).

The top portion of the table also shows that in any given year the shape of the distribution of interest rates (and for user costs) is relatively similar for each of the three proxies; the means, standard deviations and various percentiles of the distributions are close. Although by definition the rate on the most expensive credit line is always above the other rates, usually by several hundred basis points. (Note that the small sample size in 1996 is due to the correction we make to take into account the Tremonti law: in order to calculate the user cost five consecutive years of prior data are needed to see if a firm qualifies for the tax break.)

The bottom portion of the table shows that there are in fact considerable differences in the correlations between the different interest rates. The most notable difference is between the rate on the exhausted credit line and our benchmark rate (for the line that has the most slack). In 1996 the correlation between these two rates is only 0.37. The fact that the rates that we believe do and do not reflect the marginal cost of borrowing are so loosely correlated will allow us to test whether properly measuring the interest rate matters for estimating the slope of the IS curve. The remaining correlations in the table are much higher. The fact that the inter-correlations between the three different users costs are above 0.7 is large part due to the common tax and relative price terms embedded in each.

4.3 Banking data

Our third source of data is information on the condition of the lenders taken from supervisory records of the Bank of Italy. These records contain a general assessment of the financial condition of each bank, as well as detailed information on the bank. The second of these is important since, as our model indicates, bank characteristics that drive interest rates will be useful instruments for uncovering the slope of the IS curve.

Table 3 shows means, medians and standard deviations for a number of bank characteristics for both the total sample and the sub-sample of banks that report the interest rate. As noted earlier, the interest rate reporting banks are the largest in the country and the table shows that they tend to do much less small business lending (as a proportion of total lending) and inter-bank lending than smaller banks.

But importantly, in terms of cost ratios, loan losses, and market concentration indicators the large banks appear to be similar to the rest of the industry.

Moreover, there is a great deal of cross-sectional and time series variation in many of these characteristics. For instance, even among the interest rate reporting banks there are big difference in the size of the institutions. Similarly, the exposure to bad farm debt was widely disbursed. This variation is the key to our estimation approach.

5. Empirical specification

The model in section 3 suggests that the slope of the IS curve can be estimated provided that we can identify bank characteristics that affect the interest rates charged to specific firms. But to implement this we need to specify a specific equation relating investment to the interest rate. We start by deriving an equation of this sort and then show how it performs with aggregate and disaggregated data.

5.1 Deriving an empirical specification

Our estimating equation is derived by combining an assumed long run (or steady-state) model with a hypothesized adjustment cost specification. The long run model follows Mairesse, Hall and Mulkay (1999), and posits a constant elasticity of substitution production function for a firm that is a cost-minimizer that takes prices as given. In this case (neglecting a possible multiplicative constant) the optimal capital stock, K_t^*, is:

$$K_t^* = Y_t^{\vartheta} R_t^{\sigma} A_t^{\gamma} \,. \qquad (1)$$

Where Y_t is the output level, R_t is the user cost of capital, and A_t an index of technical progress. This specification nests the case of a Cobb-Douglass production function, where ϑ=1, σ=1 and γ=0; also, whether or not the production function is Cobb-Douglass, ϑ=1 if the production function exhibits constant returns to scale.[13]

As K^* is not observable, to go from (1) to an empirically implementable specification we need to specify an adjustment process that maps K into K^*. We postulate the following relatively general adjustment process:[14]

$$K_t = [(K_t^*)^{\mu_1} (K_{t-1}^*)^{\mu_2} (K_{t-2}^*)^{1-\mu_1-\mu_2}]^{1-\lambda_1-\lambda_2} (K_{t-1})^{\lambda_1} (K_{t-2})^{\lambda_2} . \tag{2}$$

Taking logs of (2) and using a log version of (1) to eliminate log(K^*) we get:

$$k_t = \omega_1 k_{t-1} + \omega_2 k_{t-2} + \omega_3 y_t + \omega_4 y_{t-1} + \omega_5 y_{t-2} + \omega_6 \rho_t + \omega_7 \rho_{t-1} + \omega_8 \rho_{t-2} + \omega_9 a_t + \omega_{10} a_{t-1} + \omega_{11} a_{t-2} \tag{3}$$

with small case variables representing logs (ρ being the log of R).

Equation (3) can be re-parametrized as an error correction model (ECM):

$$\Delta k_t = \varphi_0 + \varphi_1 \Delta k_{t-1} + \varphi_2 \Delta y_t + \varphi_3 \Delta y_{t-1} + \varphi_4 \Delta \rho_t + \varphi_5 \Delta \rho_{t-1} - \varsigma (k_{t-2} - \psi\, y_{t-2} - \chi \rho_{t-2} - \zeta\, a_{t-2}), \tag{4}$$

where, recalling that Δa is a constant if A is an exponential function of time:

$\varphi_0 = (2\omega_9 + \omega_{10}) g$, ($g$ comes from $A_t = e^{gt}$), $\varphi_1 = (\omega_1 - 1)$, $\varphi_2 = \omega_3$, $\varphi_3 = \omega_3 + \omega_4$, $\varphi_4 = \omega_6$,

$\varphi_5 = \omega_6 + \omega_7$, $\varsigma = (1 - \omega_1 - \omega_2)$, $\psi = \dfrac{\omega_3 + \omega_4 + \omega_5}{(1 - \omega_1 - \omega_2)}$, $\chi = \dfrac{\omega_6 + \omega_7 + \omega_8}{(1 - \omega_1 - \omega_2)}$, $\zeta = \dfrac{\omega_9 + \omega_{10} + \omega_{11}}{(1 - \omega_1 - \omega_2)}$.

[13] A prediction that the coefficient on Y should be one if the production function exhibits constant returns to scale is true even starting from more general production functions than considered by Mairesse et al. However, in these more general cases, if the coefficient on Y is less than one, it cannot be mapped directly into a parameter of the production function.

[14] Note that under (2) when K^* is constant, K converges to K^*. Also, if K^* grows at a constant rate, there will in general be restrictions on the parameters of the adjustment process (usually referred to as "super-homogeneity" restrictions) that guarantee that K^* converges to K; in this case, $\lambda_1 + (1 - \lambda_1 - \lambda_2)(2\mu_1 + \mu_2) = 2$ is the required parameter restriction (a stability condition is also required: here, $\lambda_1 + \lambda_2 < 1$). However, we will not worry about super-homogeneity.

This specification allows a test of the production function assumption (for example, if there are constant returns to scale ψ should be 1). Also note that unless ζ=0 (which would be the case if the production function is Cobb-Douglas), a trend (or a set of time dummies) should be included in the ECM term.

5. 2 Macroeconomic evidence

Before discussing the estimates using the firm-level data, it is useful to estimate equation (4) on macroeconomic data in order to establish whether the generic concerns about macro data are present in Italy when using our preferred empirical specification. Table 4 shows the results of estimating the investment equation on quarterly aggregate data from 1970 to 1999.

Our dependent variable here as well as in the subsequent firm level estimates is gross-investment as a share of the beginning of period net capital stock in the private sector. This is better measure of the investment rate than that obtained taking first differences of the (log of the) stock of capital, especially in the micro data, where data on the stock of capital may be subject to revaluations. We proxy output with the real value added and measure the rate of interest with the average interest rate on bank loans. For comparison we also report estimates using the user cost of capital.[15] The first two columns show the OLS and the IV estimates using the rate on bank loans as the interest rate variable. According to the OLS estimates, the interest rate on loans has a negative and statistically significant effect of on the investment rate, but its long run effect on the stock of capital is small, with an elasticity equal to –0.043. This value is similar to those obtained in the literature and confirms the well known difficulty of finding strong effects of the interest rate on aggregate investment.

The second column reports the IV estimates using as instruments the log of real exports, the log of public consumption, and the current and one lagged value of the Deutsche Mark interest rate. These

---

15 Our user cost definition is the standard one, namely the real cost of finance (calculated as an average external and internal funding cost) finance, plus depreciation, net of depreciation allowances and tax provisions, with all these factors scaled by the ratio of investment to output prices.

estimates illustrate the other difficulty that emerges when using aggregate time series: the IV estimates are not appreciably different than the OLS ones.

The most likely explanation is that it is hard to find truly exogenous variables that correlate with investment at the aggregate level. We reach this same conclusion if we replace the interest rate on loans with the user cost of capital, as we do in the third and fourth columns. In this case too the elasticity of the stock of capital to the user cost is statistically significant but still very low (-0.061); recall that a Cobb-Douglas production function would imply an elasticity of –1. Once again notice that the IV estimates shown in column 4 are very close to both the ones in column 3 and to those obtained using the interest rate on bank loans rather than the cost of capital.

6. The investment sensitivity to the interest rate in microeconomic data.

Turning to the micro data, we use firms' sales as our proxy for the level of product demand faced by the firm. Our dependent variable is the firm reported value of the annual flow of investment in structures, vehicles, machines and equipment scaled by the beginning of period book value of the stock of capital. This variable is likely to be less subject to measurement error than the one obtained using first differences in the book value of the stock of capital, mainly because the latter may be affected by re-valuations.

We then take a number of steps to organize the data for our regression analysis. In order to avoid undue influence of mergers and acquisitions on the flow of investment, we have excluded all observations for which the gross investment flow exceeds the beginning of period capital stock, or the capital stock and sales grow by more than 100% or decline by more than 50%. This leads to the exclusion of about 25,000 observations out of a total of more than 500,000 firm-year observations in the initial CB sample. To recover the firm-level interest rate we merge the CB sample with the Credit Register information. This knocks out firms that do not have any contact with the major banks. After the merge, we are left with about 361,000 firm-year observations. Finally, the construction of growth rates and inclusion of lags at *t*-2 leads to a further loss of observations leaving us with a reference sample of about 130,000 observations (for the years between 1989 and 1998). As mentioned above, whenever we need to construct the user cost of capital taking into account the tax credit granted by the Tremonti law, we require observations for 6 years, so this leads to the loss of roughly another 18,000 observations.

6.1 Estimates of the interest sensitivity of investment

We begin by repeating the same exercises that we conducted with the macro data: first correlating investment and interest rates, and then replacing the interest rate with the user cost of capital. The first column of Table 5 shows the OLS estimates of equation 4 (when fixed effects are included). There are several noteworthy findings. First, the investment rate appears to exhibit negative autocorrelation, although the coefficient on the lagged investment/capital ratio is relatively small. This is in contrast with the estimates based on macroeconomic data which show marked positive autocorrelation.

Both current sales growth and lagged sales growth are significantly positively correlated with investment: a 5% increase in this year and last year's growth in sales would increase the investment rate by roughly 8/10 of a percentage point, or 7.7% of the sample mean. The error correction terms have the expected sign and are highly statistically significant: the lagged capital stock lowers current investment while a high level of past sales increases it. However, the coefficient on sales is significantly smaller than that on the stock of capital, a point we discuss further below.

Most importantly, the effect of the rate of interest in negative and statistically significant (t-value 4.65) but the coefficient is small (-0.0093): for a firm with an interest rate on loans of 10% a derease in the rate of interest by 1 percentage point would, on impact, increase the investment-capital ratio by 0.00093.[16] The bottom of the table shows the long run elasticity of the stock of capital to the interest rate: for the OLS estimates this is only –0.0461, a value that is very close to the estimates obtained using aggregate data. Thus, using the firm-level data does not by itself lead to higher estimated elasticities.

The next column of the table shows that using lagged values of the interest rate as instruments for the current interest rate also does not lead to a larger elasticity. For this specification, the IV estimate has the wrong sign, although it is not significant. All the other coefficient estimates are essentially unchanged. So this is also very similar to the results we found with aggregate data.

We then show our main finding, i.e. that using better instruments we find a massively higher interest sensitivity of investment. In keeping with the model, we have chosen instruments variables that affect a bank's funding costs. We use six instruments: the size of the bank (measured by the log of total assets), the bank's share of bad loans to agriculture, the share of bad loans to households, the bank's net position in the inter-bank market, the ratio of the bank's labor costs to total costs and the Herfindahl index of the bank's deposits. The first three measures represent our "core" set of instruments, obtained excluding from the full set the labor cost and inter-bank variables (whose exogeneity might questioned) and the bad loan variable for households (which is not very volatile and could be considered redundant once one includes the bad loans to farmers).

These measures are meant to capture banks characteristics that are related to the cost of lending. For instance, smaller banks are likely to face more severe agency problems and to have to pay higher rates if they do issue certificates of deposits or bonds. Similarly banks that are lending in the inter-bank market can redeploy these assets if they are faced with a funding shock (Kashyap and Stein, 2000).[17]

[16] We also experimented with including changes in interest rates (current and lagged) and found that they were typically insignificantly different from zero, so they are not shown. The results are also very similar if the lagged level of the rate is used instead of the current level of the interest rate.

[17] In the regressions we use a dummy that equals one when the bank has a net creditor position in the interbank market and 0 if it has a net debtor position.

The share of bad loans to households and agriculture are two measures of the riskiness of the banks portfolio: the riskier the loan portfolio the higher the premium a bank needs to pay to raise external funds. We use the losses on the non-business loans to avoid picking up any risk-premia that might be directly related to the firm's riskiness. The ratio of the bank's labor costs to total costs should partially reflect differences in banks' operating efficiency that would need to be recovered through lending premia.

The Herfindahl index of bank deposits should capture market power. As shown by Focarelli and Panetta (2002), interest rates on deposits vary significantly across local markets reflecting differences in concentration and market power . For each bank *i*, the instrument is the weighted average of the Herfindahl index of the deposit market in the provinces where the bank has branches. The weights are represented by bank i's deposits in each province *k* as a proportion of the bank's total deposits, i.e:

$$\sum_k HERF_k * \frac{DEPOSIT_{i,k}}{DEPOSIT_i}$$

where HERF is the Herfindahl index of the deposit market in each province.

These instruments collectively explain a great deal of variation in the interest rates. For instance, in a (unreported) regression of the (log of the) rate on these instruments together with a full set of firm and time dummies) an F-test overwhelmingly rejects the null hypothesis that the coefficients of the instruments are all zero (the F-value is 161).

The results using all the of instruments are shown in column 4 of the table. For all variables other than the interest rate the IV estimates are essentially the same as those obtained with OLS. However, the estimated coefficient on the interest rate in now much larger. For a firm with an interest rate on loans of 10%, on impact a one percentage point increase in the rate of interest increases the investment/capital ratio by 0.00572, roughly six times as large as the effect implied by the OLS estimates. The estimated long run elasticity of the stock of capital to the interest rate is -.28, also six times larger than the OLS estimates, implying that a permanent 1% increase in the rate of interest lowers the long run capital stock by about one quarter of a percentage point. The difference between the OLS and the IV estimates suggest that even in micro data, OLS estimates produce estimates that are severely biased downwards; however, unlike in the macro data, our instruments allow us to correct for this bias.

The third column in the table reports estimates based on the “core” set of instruments: the elasticity is slightly larger relative to the OLS estimate than for the full set of instruments and the remaining coefficients are quite similar to the OLS estimates.

While our discussion is focusing on the large point estimates of the long run user cost elasticity it is fair to recognize that these long run coefficients are not very precisely estimated. This is undoubtedly due to the fact that while are instruments are hard to criticize as being tied to investment demand, they do not explain all or even most of the variation in interest rates; particularly since the common time variation will be knocked out by the dummy variables in our regressions. The more relevant consideration is that the point estimates consistently jump when the bank instruments are used and the contemporaneous coefficients are almost always significantly different from zero.

For both the larger and smaller instrument lists the Sargan test for the validity of the instruments suggests that there are specification problems. One potential explanation for the specification problems could be the possibility that the lagged dependent variable is correlated with the disturbances in the equations. To address this possibility, in the last three columns we report the Anderson & Hsiao first-differenced estimator. The instruments in this case are the investment/capital ratio and the log sales at lag three. In the fifth column of the table the interest rate is only instrumented using lags of itself, while in the last two columns the bank characteristics as used instruments. When the bank instruments are not used, the interest rate coefficient again has the wrong sign, although it is not precisely estimated. However, once again when the core set of bank instruments are used the impact elasticity becomes negative and significantly different from zero (roughly at the 10% level of significance). The long run elasticity of the capital stock is again around -0.25.

These first difference estimates also pass the tests of the over-identifying restrictions for the instruments. We suspect this is at least partially attributable to the fact that the first difference of the interest rate is closer to the first difference of the theoretically preferred user cost; if the non-interest components of the user cost primarily vary across firms (rather than over time), then the fact that these components are omitted will not induce much misspecification once differences are taken.

The main economic difference between these estimates and the others in the table is the larger gap between the size of the coefficients of the lagged sales and lagged capital variables. The sales coefficient is about ¼ the size of the capital coefficient. Although the potential mis-specification by controlling for the interest rate instead of the user cost could be important, we will see that this same pattern of much lower coefficients on the sales variable relative to capital is a recurring pattern in almost all of our regressions. Moreover, the other clear pattern from the levels regression also carries over: when the interest rate is instrumented with a number of potentially relevant bank characteristics the estimated effect of the interest rate becomes at least a factor of five times larger than when it is not instrumented.

One immediate question raised by the table 5 results is whether the bank instruments are so important that they would uncover large interest rate sensitivities for any interest rate proxy. To address this, in Table 6 we repeat the exercise in Table 5 with the other two interest rates.

We draw three strong conclusions from Table 6. First, when we use the other candidate marginal borrowing rate, the highest rate that has been tapped, the results are similar to the Table 5 findings. Namely, the interest sensitivity is markedly higher with the bank instruments than when the lagged interest rate is used (roughly -0.14 without the bank instruments vs. -0.42 with the core instrument set). We also found a high estimated interest rate sensitivity for the only other candidate for the marginal borrowing rate that we considered.[18]

But this finding does not carry over for all interest rate proxies. The sensitivity of investment to the "non-marginal rate" that we chose (based on credit lines with the smallest unused balance) is always estimated to be zero or positive (and is never significant). Indeed, the estimates in columns 2 and 3, where the bank instruments are used, are never different from those in column 1 where just lagged interest rates are used as instruments. We conclude from this evidence that the quality of the interest rate proxy and the instruments are both important in delivering the high interest rate sensitivities seen in table 5.

Finally, all of the specifications in Table 6 show the same patterns for the coefficients on the non-interest rate variables. In particular, there are consistently large differences in the size of the coefficients on the capital and sales variables. The lagged sales growth variables are always positive and statistically significant from zero and the lagged dependent variable is always statistically significantly less than zero.

6.2 Estimates of the elasticity of investment with respect to the user cost of capital

We now turn to estimating the elasticity of investment (and capital) with respect to the user cost of capital. We begin replicating Table 5, but replacing the interest rate with the user cost. As mentioned above, the Tremonti tax credit guarantees that an OLS regression will show a spuriously large user cost elasticity, so we skip directly to estimates using instrumental variables.[19] The estimation using the levels of the variables is shown in the first three columns of Table 7. The usual finding of negligible user cost effects is uncovered in column 1; in this case the coefficient is actually positive, when only

[18] We considered using the rate on the credit line from the bank that had the highest level of previously granted loans. This might represent the lending rate of a firm's primary lender. This results with this rate are qualitatively similar to those for the highest rate so we omitted them to save space.

[19] If we drop the years where the Tremonti law was in place then the usual finding of a tiny user cost elasticity emerges.

lagged values of the user cost are used as instruments. The Sargan test also suggests specification problems with this equation.

The next two columns show that when either the full set of bank instruments or the core set is used we find large, albeit somewhat imprecisely estimated, user cost elasticties. For the core set of instruments the impact coefficient of the user cost is –0.177 (significant at the 6 percent level); with the full set of instruments the point estimate is similar but more precise (the estimated coefficient is – 0.198, significant at the 1 percent level). As shown in the 7th row of the table, the long run estimate of the user cost is -0.925 using the full set and -1.04 using the core set of instruments.

Although our estimates carry relatively large standard errors (partly to be expected, given that our instruments can only induce small shifts in the loan supply curve) we find our results encouraging for several reasons. First, it is clear that the direct impact of the user cost elasticity rises by a factor of 10 as a result of using the instruments. Second, the Sargan tests suggest that the equations are reasonably specified, particularly when the core instrument set is used. Third, the results are also confirmed when the Anderson-Hsaio first difference estimator is used. Specifically, the user cost elasticity again is near negative one when either set of bank instruments are used and is insignificantly different from zero when they are not used. Moreover, the specification tests comfortably pass. Overall, we read these results as confirming that once we identify even small amounts of supply induced variation in the cost of capital it appears that the effects of this variation are quite important for investment.

As an aside, a back of the envelope calculation suggests that the implied interest rate effects from these estimates are consistent with the estimates in Table 5. In particular, since the elasticity of the average interest rate with respect to the user cost is about 0.3, a user cost elasticity of -1, implies an interest rate elasticity of -0.3. This is in the ballpark of the estimates found in Table 5.

Finally, as in the prior two tables, the coefficients on the remaining control variables show the same patterns across all the specifications. Lagged sales growth has strong positive effects on investment. The error correction term is very significant, and the coefficients on capital consistently exceed those on sales. This suggests a large degree of increasing returns to scale, as would be predicted if firms faced non-trivial fixed costs of operating. Given the small size of the typical firm in our sample this finding is not surprising. Also, the negative coefficient on the lagged dependent variable is common across all the specifications.

To explore the robustness of these findings we repeat the regressions using alternative user cost variables that are based on the two alternative interest rates. These findings are reported in Table 8. Several patterns are quite clear. First, for either alternative user costs, when the bank instruments are not used the elasticities are insignificantly different from zero. Second, when the bank instruments are used the elasticities are quite different depending on which proxy is used. For the user cost based on the highest drawn rate (our other contender for the marginal rate), the long run estimated elasticity is consistently negative. The long run effects vary depending on the set of instruments used; the estimates range between -0.23 when the core set is used and -0.70 when the full set is used. In contrast, when the non-marginal rate is used the estimated elasticity has the wrong sign and is never significant.

Our conclusion from Table 8 is that investment is not responsive to a user cost estimate that is based on the interest rate that is a relatively poor proxy for the marginal borrowing cost. It appears more responsive to the alternative marginal rate that we considered. But the size of the elasticity for this proxy is sensitive to the instrument choice.

7. Some preliminary robustness checks

We close by exploring three additional implications that are raised by the claim that our instruments combined with a plausible proxy for the marginal borrowing costs suggest a high sensitivity of investment to interest rates. First we consider a pair of alternative specifications for the regression equation. Next we alter the sample used in estimation. Lastly we consider the impact that liquidity constraints might have on our findings. In the interests of brevity, in all of what follows we stick to our core set of bank instruments

One serious concern is that the results in the last four tables might be excessively influenced by the ad-hoc estimating equation that we have chosen. Because there is still no consensus in the literature on firm level investment over how best to model investment, we do not have the option of starting from a baseline specification that is widely embraced. To see whether our results are robust we re-estimated the equations using the specification by Cummins, Hassett and Hubbard (1994).

We adopt their specification for two reasons. First, it is extremely simple, almost implausibly so as a serious model of investment. Second, the simplification is obtained by ignoring all the dynamics, which are the most arbitrary component of our specification. Thus, it seems reasonable to suspect that many people would settle on a specification somewhere between theirs and ours. Put differently, among the widely-cited papers in this literature their specification is the farthest from ours.

The results are shown in Table 9. The first two columns shows the estimates when just user cost (and a set of time dummies) are included as control variables. In the first column, only lags of the user cost are chosen as instruments. In this case the coefficient is positive and significant. The second column shows that substituting instead our bank specific instruments reverses the sign of the coefficient, so that the elasticity is estimated to be negative and significant. The last column in the table shows that this finding persists even if a cash flow variable is added to the specification. Cash flow does come in with a very large t-statistic, but the user cost elasticity is hardly affected.

Given the lack of all dynamics, it is remarkable that the specification tests are passed. Nonetheless, we are hesitant to take the coefficients seriously. For example, the equation as estimated does not allow one to compute the steady state relation between the capital stock and the user cost. So we draw no quantitative conclusions from Table 9, but do see the results as confirming the power of the bank instruments.

We further pursue the potential specification problems by amending our basic specification. One tact is to include cash flow in our baseline specification. These results are shown in the first two columns of Table 10. The addition of cash flow to the full sample leads to lower, but still substantial estimates of the long run user cost elasticity. Given the size of the standard errors, however, we cannot tell these estimates from the comparable ones in Table 7. The cash variable itself is significant only in the level estimation and does little to the coefficients on the other variables.

We also re-run the baseline specifications for firms with fewer than 80 employees. The idea here is to isolate smaller firms that would presumably face switching costs of finding new credit if it was needed. For these firms we expect the existing credit lines to better reflect credit availability; they are not typically going to be able to access non-intermediated financing or to secure new intermediated funding on short notice.

Unfortunately, for most firms in our sample the data on employment is missing. So the sample sizes fall dramatically when we make these splits and the standard errors rise markedly, particularly for the Anderson-Hsiao estimator. The sampling/estimation error is large enough that we cannot draw any strong conclusions from these contrasts. In future drafts of this paper we plan to explore more fully this kind of test.

Our last robustness check looks at whether liquidity constraints might be driving our findings. As mentioned earlier, if firms are not at a corner, then a collateral constraint will be exacerbated by a change in interest rates. If the impact on collateral is not modeled, then it would be possible to overstate the interest rate (or user cost) elasticity.

To address this concern we split the sample into firms which might be liquidity constrained and those which are unlikely to be constrained. The firms that are not expected to face collateral or borrowing restrictions are firms with high ratios of cash flow to interest payments (normalized by the standard deviation of cash flow); the exact cutoff is that these firms must have the standardized coverage ratio above the median for the sample. Firms where this standardized interest coverage ratio is large are ones with substantial debt capacity, for which we would expect to have little trouble raising money to finance capital expenditure even when collateral value changes in response to variation in market rates.

The results for these firms are shown in the first two columns of Table 11. The results are qualitatively similar to the baseline findings from Table 7. The contemporaneous coefficients on the user cost are significant at the five percent level. The long-run user cost elasticity is around -1.2 regardless of which estimation procedure is used. Unfortunately, here again we have significantly cut down on the sample size and the standard errors on the long run user cost elasticity reflect that. Finding an alternative way to conduct this test is another topic for future work.

The remaining columns in the table show estimates for a set of firms where they have nearly exhausted all of their credit lines; in particular the firms in this sample are those for which the total amount of loans that they have outstanding relative to credit lines granted put them in the upper 20% of the sample distribution. Typically this means that they have about 78% of their credit taken down. Provided that these firms are not literally rationed we would expect to find higher (in absolute value) user cost elasticities. This does not appear to be the case. However, by cutting back to 20% of the sample the standard errors on the user cost become quite large. So this contrast is relatively uninformative.

On the basis on all the robustness tests we conducted thus far, we see no strong evidence against the view that the bank level instruments are quite valuable in identifying the responsiveness of investment to the user cost. In particular, this finding does not appear to be peculiar to our specification nor does it seem to be coming from omitting other potentially relevant explanatory variables for investment.

One last test that we plan to do in the next draft is to explore the potential importance of irreversibility. We believe this can be partially accomplished by sorting firms based on their ex-post rates of investment. For firms that actually invested at high rates we would assume that irreversibility was not a problem. For these firms standard OLS estimates of the interest rate elasticity should be biased upwards because of the way in which we select the firms; the opposite bias should be present for firms that had very low rates of investment. By comparing these estimates to the others where instruments have been used we expect to get a loose bound on the importance of irreversibility.

8. Conclusions

Our findings suggest that a combination of simultaneity bias and measurement error is the major reason why investment appears to be so insensitive to interest rates. In particular, using both aggregate and firm-level data we can replicate the typical finding that investment is not responsive to interest rates or the cost of capital. However, once we identify supply induced variation in the cost of capital the responsiveness jumps substantially, provided that the borrowing rate under consideration is a reasonable proxy for firms' marginal borrowing costs. This result vanishes when we use a poor interest rate proxy or when we rely on standard instruments that fail to pick up supply induced cost variation.

Our preferred estimates of the long run elasticity of capital with respect to the user cost of capital cluster around -1.0, the value predicted by a Cobb-Douglas production function. However, most of the estimates have large standard errors so we cannot typically reject much lower estimates. The data do consistently show that there are increasing returns to scale at a firm-level, consistent with firms facing a fixed cost of operating. Given the prevalence of small firms in our sample we find this result plausible.

Data Appendix

A. 1. The CB dataset

The Italian Company Accounts Database – *Centrale dei Bilanci* - is a large data set collecting balance sheet information and other items on a sample of over 30,000 Italian firms. The data, available since 1982 and up to 1998, are collected by Centrale dei Bilanci, an organization established in the early 1980s jointly by the Bank of Italy, the Association of Italian Banks (ABI) and a pool of leading banks with the intent of building up and sharing information on borrowers. Besides reporting balance sheet items the database contains detailed information on firms demographics (year of foundation, location, type of organization, ownership status, structure of control, group membership etc.), on employment, and their flow of funds. Balance sheets are reclassified in order to reduce the dependence of the data on the accounting conventions used by each firm to record income figures and asset values. Balance sheets for the banks' major clients (defined according to the level of their borrowing) are collected by the banks. The focus on the level of borrowing skews the sample towards larger firms. Furthermore, because most of the leading banks are in the Northern part of the country, the sample has more firms headquartered in the North than in the South. Finally, since banks are most interested in firms that are creditworthy, firms in default are not in the data set, so that the sample is also tilted towards higher than average quality borrowers. Despite these potential biases the comparison between sample and population moments in Table 1 appears to suggest that the CADS is not too far from being representative of the whole population. This is confirmed by the data reported in Table A1 which compares the marginal frequency distribution by size and geographical location in the sample and in the population in 1990. While the geographical distribution of firms in the sample is not too far from that in the population, it is biased towards larger firms especially those with more than 999 employees.

A. 2. The construction of the user cost of capital

This reiterates the information from Gaiotti and Generale (2001) on how they constructed the cost of capital measure that we use.[20] Their derivation of the user cost of capital follows from the

[20] We thank Andrea Generale and Eugenio Gaiotti for making their data set on the user cost of Italian firms available to us.

firm's optimization problem (see Mairesse, Hall and Mulkay 1999, and Cohen, Hassett and Hubbard, 1999):

$$\text{(A1)} \qquad R_{i,t} = \frac{p^I_{s,t}}{p_{s,t}} \left(r_{i,t} + \delta_s - (1-\delta_s)\frac{\Delta p^I_{s,t+1|t}}{p^I_{s,t}} \right) \left(\frac{1 - itc_{i,t} - \tau_t z_s}{1-\tau_t} \right)$$

where p_s^I is the industry price of investment, p_s is the industry price of output, δ_s is the industry-specific depreciation rate, $\Delta p^I_{s,t+1|t} \big/ p^I_{s,t}$ is the expected change in the industry-specific price of investment, obtained from the survey of manufacturing firms conducted each year by the Bank of Italy, $r_{i,t}$ is the interest rate.

The definition also takes into account the effect of tax variables, which enter the last term on the right-hand side and is common across many studies. For Italy the relevant tax variables reflect economy-wide, industry-level, and firm-specific aspects of the tax code. In particular, the tax rate on profits (τ_t), is common to all firms in the economy. While the tax deductibility of depreciation charges (τ_t z_s) varies by industry, because the value of depreciation per unit of investment (z_s) is industry specific. (The Italian law also distinguishes between vehicles and machinery investment for each industry; averages for each sector are computed based on the share of these two items in investment.) Finally, the variable $itc_{i,t}$ represents the investment tax credit (per unit of investment). Between 1994 and 1996 the Tremonti Law described in the text provided a tax credit that differed by firm. Hence this term is calculated at the firm-level.

References

Angeloni, Iganazio, Kashyap, Anil K, Mojon, Benoit, and Daniele Terlizzese, 2002, "Monetary Transmission in the Euro Area: Where Do We Stand?", ECB Working Paper 114, revised July 2002.

Blanchard, Olivier J. 1986, "Comments and Discussion", Brookings Papers on Economic Activity, 1, 153-156.

Caballero, Ricardo J., 1994, "Small Sample Bias And Adjustment Costs," The Review Of Economics And Statistics 76 (February), 52-58.

Caballero, Ricardo J., Engel, Eduardo M.R.A., and Haltiwanger, John C., 1995, "Plant-Level Adjustment and Aggregate Investment Dynamics," Brookings Papers on Economic Activity , 2, 1-54.

Chirinko, Robert S., Fazzari, Steven M., and Meyer, Andrew P., 1999, "How Responsive Is Business Capital Formation To Its User Cost?: An Exploration With Micro Data," Journal of Public Economics 74 (October), 53-80.

Chatelain, J.B , Generale A., Hernando I, von Kalckreuth U. and Vermeulen P. , 2001, Firm Investment in the euro area, ECB Working Paper No. 112

Chirinko, Robert S., Fazzari, Steven M., and Meyer, Andrew P., 2001, "That Elusive Elasticity: A Long-Panel Approach to Estimating the Price Sensitivity of Business Capital", mimeo, January.

Christiano Lawrence J., Eichenbaum Martin and Charles L. Evans, 2001, "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy", mimeo.

Cohen, Darrel, Hassett, Kevin A. and R. Glenn Hubbard, 1999, "Inflation and the User Cost of Capital: Does Inflation Still Matter?", in Martin Feldstein ed. The Costs and Benefits of Price Stability, University of Chicago Press: Chicago, pp. 199-233.

Cummins, Jason G., Hassett, Kevin A., and Hubbard, R. Glenn, 1994, "A Reconsideration of Investment Behavior Using Tax Reforms as Natural Experiments," Brookings Papers on Economic Activity (1994:2), 1-60.

Cummins, Jason G., Hassett, Kevin A., and Hubbard, R. Glenn, 1996, "Tax Reforms and Investment: A Cross-Country Comparison," Journal of Public Economics 62, 237-273.

Detragiache Enrica, Luigi Guiso and Paolo Garella, 2000, "Multiple versus Single Banking Relationships: Theory and Evidence", Journal of Finance, 55, 1133-1161.

Fazzari, Steven, Hubbard R. Glenn, and Bruce Petersen (1988) "Financing constraints and corporate investment", Brookings Papers on Economic Activity,1, 141-195.

Focarelli Dario and Fabio Panetta (2002), "Are Mergers Beneficial To Consumers? Evidence From The Italian Market For Bank Deposits,"presented at the XXXIII Federal Reserve Bank of Chicago Conference on Bank Structure, Chicago, May.

Gaiotti, Eugenio and Andrea Generale, 2001, "Does monetary policy have asymmetric effects? A look at the investment decisions of Italian firms",Banca d'Italia, Discussion Paper , no. 429 (December).

Clarida, Richard, Gertler Mark, and Jordi Gali, 1999, "The Science of Monetary Policy: A Nre Keynesian Perspective," The Journal of Economic Literature, 37(4), 1661-1707.

Goolsbee, Austan, 1998, "Investment Tax Incentives, Prices, and the Supply of Capital Goods," Quarterly Journal of Economics , 93, 121-148.

Goolsbee, Austan, 2000, "The Importance of Measurement Error in the Cost of Capital," National Tax Journal 53(June), 215-228.

Guiso, Luigi, Sapienza Paola, and Luigi Zingales, 2001, "Does local Financial Development Matter?", National Bureau of Economic Research Working Paper 8923.

Hall, Robert E., 1988, "Intertemporal Substitution in Consumption", Journal of Political Economy, 96(2), 339-357.

Jayaratne, Jith and Philip E. Strahan, 1996, "The Finance-Growth Nexus: Evidence from Bank Branch Deregulation," Quarterly Journal of Economics, CXI, 639-671.

Joint Committee on Taxation, Joint Committee On Taxation Tax Modeling Project And 1997 Tax Symposium Papers (Washington: U.S. Government Printing Office, 1997).

Kashyap, Anil K. and Jeremy C. Stein (2000), ""What Do A Million Observations on Banks Have To Say About the Monetary Transmission Mechanism?", American Economic Review, 2000, 90(3), pp. 407- 428.

Mairesse, Jacques, Hall, Bronwyn H., and Mulkay, Benoit, 1999, "Firm-Level Investment In France And The United States: An Exploration Of What We Have Learned In Twenty Years," NBER Working Paper No. 7437.

Petersen, Mitchell and Raghuram Rajan (2000) "Does Distance Still Matter? The Information revolution in Small Business Lending" NBER Working Paper n. 7685

Rajan, Raghuram.G., 1992, "Insiders and Outsiders: the Choice Between Informed and Arm's-Length Debt", Journal of Finance, 47, 1367-1400.

Rotemberg, Julio J. and Micheal Woodford (1999) "Interest Rate Rules in an Estimated Sticky Price Model" in John B. Taylor ed Monetary Policy Rules, University of Chicago Press, Chicago, pp. 57-119.

Rudebusch, Glenn D. and Lars E.O. Svensson (1999) "Policy Rules for Inflation Targeting" in John B. Taylor ed Monetary Policy Rules, University of Chicago Press, Chicago, pp. 203-247.

Sharpe, Steven, 1991, "Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships", Journal of Finance, 45, 1069-1087.

Smets, Frank and Raf Wouters, 2002, "An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area", mimeo.

Woodford, Michael, 2002, Interest and Prices: Foundations of a Theory of Monetary Policy, Princeton University Press, in preparation.

Table 1. The firm sample: selected years

The table shows summary statistics for the sample of firms in selected years. Sales are measured in billion of lire at current prices.

A. Total sample

Variable	Number of Observations	Mean	Median	Standard Deviation
			1992	
Investment/ fixed capital	33,784	0.126	0.071	0.159
Sales/fixed capital	33,703	16.19	5.58	163.98
Sales	33,703	31.89	8.95	288.80
Rate of growth of sales	31,977	0.042	0.034	0.199
			1996	
Investment/ fixed capital	28,576	0.145	0.086	0.172
Sales/fixed capital	28,514	28.18	4.62	306.19
Sales	28,514	41.99	16.18	419.94
Rate of growth of sales	26,970	0.027	0.021	0.200
			1998	
Investment/ fixed capital	28,602	0.141	0.084	0.168
Sales/fixed capital	28,551	30.12	4.59	367.53
Sales	28,551	57.62	18.9	482.4
Rate of growth of sales	27,210	0.058	0.045	0.195

B. Sample of firms with marginal interest rate

Variable	Number of Observations	Mean	Median	Standard Deviation
			1992	
Investment/ fixed capital	25,375	0.126	0.073	0.157
Sales/fixed capital	25,338	14.62	3.61	145.27
Sales	25,338	23.10	9.09	124.20
Rate of growth of sales	24,278	0.043	0.034	0.194
			1996	
Investment/ fixed capital	21,466	0.147	0.089	0.147
Sales/fixed capital	21,441	22.24	4.52	192.26
Sales	21,441	38.39	16.36	192.27
Rate of growth of sales	20,508	0.026	0.021	0.195
			1998	
Investment/ fixed capital	23,477	0.139	0.084	0.162
Sales/fixed capital	23,456	20.85	4.30	147.24
Sales	23,456	60.75	19.67	474.21
Rate of growth of sales	22,689	.045	0.042	0.179

Table 2. Firm specific interest rates and the user cost of capital over time

Panel A shows summary statistics on three measures of the firm specific interest rates on credit lines and the associated user cost of capital. *Interest rate 1* is the rate charged on the line that has the most unused credit; *interest rate 2* is the rate charged on the line that has the least unused credit; *interest rate 3* is the highest rate on the various lines that have been tapped. *User cost 1* is based on *interest rate 1*; *User cost 2* is based on *interest rate 2*; *User cost 3* is based on *interest rate 3*. Panel B reports correlations between the various measures of the interest rate and the user cost for 1996.

A: Statistics on interest rates and the user cost

Variable	Obs.	Mean	Median	Stand. dev.	1st perc.	99th perc.
			1992			
Interest rates on credit lines:						
Interest rate 1: largest unused line	25,938	.195	.186	.037	.136	.327
Interest rate 2: smallest unused line	25,938	.195	.187	.036	.135	.321
Interest rate 3: highest rate	25,938	.222	.216	.044	.149	.350
User cost						
User cost 1	25,938	.223	.221	.021	.180	.282
User cost 2	25,938	.222	.221	.021	.179	.281
User cost 3	25,938	.234	.233	.023	.185	.294
			1996			
Interest rates on credit lines:						
Interest rate 1: largest unused line	12,407	.133	.120	.044	.083	.301
Interest rate 2: smallest unused line	12,407	.135	.122	.044	.083	.296
Interest rate 3: highest rate	12,407	.172	.159	.060	.089	.337
User cost						
User cost 1	12,407	.171	.167	.026	.126	.249
User cost 2	12,407	.171	.168	.026	.125	.248
User cost 3	12,407	.185	.182	.031	.130	.271
			1998			
Interest rates on credit lines:						
Interest rate 1: largest unused line	25,586	.095	.083	.042	.045	.256
Interest rate 2: smallest unused line	25,586	.098	.085	.042	.044	.254
Interest rate 3: highest interest rate	25,586	.128	.113	.055	.049	.286
User cost						
User cost 1	25,586	.157	.154	.026	.108	.241
User cost 2	25,586	.158	.155	.026	.109	.240
User cost 3	25,586	.172	.168	.032	.115	.260

B. : Covariances

Variable	Interest rate 1	Interest rate 2	Interest rate 3	User cost 1	User cost 2	User cost 3
			1996			
Interest rate 1	-	0.374	0.574			
Interest rate 2		-	0.593			
Interest rate 3			-			
User cost 1	0.655			-	0.736	0.784
User cost 2		0.652			-	0.793
User cost 3			0.753			-

Table 3. Characteristics of the banks lending to the firms in our sample

The table shows the mean value, median value [in square brackets] and standard deviation (in parentheses) of bank characteristics for selected years. Total assets are in billion lire, at current prices. Reporting banks are those that report information on interest rates charged to individual borrowers to the Central Credit Register. For each bank the Herfindahl index is the weighted average of the Herfindahl index for the deposit markets in the provinces where the bank lends, using as weights deposits shares of the market. Short term loans are the share of loans with maturity below 18 months; lending to small firms is defined as the share of total loans of loans to businesses whose amount is below 5 billion lire. Bad loans to agriculture and households are the shares of defaulted loans to agriculture and households respectively relative to performing loans. The net position in the interbank market is defined as the balance between the creditor and debtor bank position in the market, as a percentage of the bank's assets. Labor costs are share of total gross wages and this is divided by total firm revenue.

Variable	*All banks*			*Reporting banks*		
	1992	1996	1998	1992	1996	1998
Total assets	2,221	3,068	3398	19,575	26,426	29,951
	[137.6]	[234.9]	[287.5]	[6,100]	[9,786]	[14,451]
	(10,129)	(13271)	(14,484)	(30,804)	(39,805)	(43229)
Loans/total assets	.359	.359	.399	.382	.376	.423
	[.345]	[.349]	[.399]	[.386]	[.375]	[.407]
	(.126)	(.138)	(.159)	(.060)	(.062)	(.072)
Herfindahl	.141	.133	.133	.157	.156	.154
(deposits)	[.124]	[.119]	[.120]	[.151]	[.147]	[.144]
	(.069)	(.064)	(.067)	(.061)	(.058)	(.055)
Short term loans	.639	.574	.531	.783	.663	.618
	[.632]	[.566]	[.526]	[.813]	[.687]	[.632]
	(.176)	(.172)	(.189)	(.116)	(.137)	(.132)
Lending to small	.668	.652	.626	.393	.391	.355
firms	[.745]	[.745]	[.707]	[.385]	[.366]	[.360]
	(.262)	(.265)	(.256)	(.121)	(.118)	(.117)
Bad loans to	.133	.294	.230	.211	.268	.281
agriculture	[0]	[.196]	[.149]	[.0798]	[.154]	[.124]
	(.372)	(.453)	(.223)	(.517)	(.413)	(.547)
Bad loans to	.100	.118	.120	.076	.097	.081
households	[.056]	[.066]	[.054]	[.053]	[.076]	[.061]
	(.207)	(.192)	(.161)	(.138)	(.075)	(.076)
Labor	.361	.407	.378	.408	.418	.380
cost/revenues	[.360]	[.361]	[.344]	[.401]	[.409]	[.380]
	(.231)	(.820)	(.770]	(.071]	(.091]	(.068]
Net position in the	.053	.068	.061	.037	.037	.039
interbank market	[.055]	[.075]	[.062]	[.029]	[.029]	[.027]
	(.099)	(.144)	(.153)	(.053)	(.057)	(.053)

Table 4. Investment and the interest rate in macroeconomic time series

The table reports several specifications of the investment equation using aggregate quarterly data from 1970 Q1 to 1999 Q2. The left hand side variable is gross private investment divided by the net capital stock of the private sector. The first two columns use the average real rate on banking loans as the interest rate; in the third and fourth columns, the user cost of capital is used. The instruments in the IV estimates are the log of real exports, the log of public consumption expenditures, and the current and lagged value of the Deutsche Mark interest rate. Standard errors are reported in parentheses. Lower case letters denote logs and upper case denote levels.

	OLS	IV	OLS	IV
I/K(t-1)	0.8175	.8621	.8336	.8468
	(0.0341)	(.0410)	(.0318)	(.0358)
Log(Int Rate)	-.0004	-.0002		
	(0.00011)	(.00016)		
Log(User cost)	-	-	-.0005	-.0003
			(.0002)	(.0004)
Δsales	.02218	.0237	.0239	.0243
	(0.0025)	(.0027)	(.0025)	(.0025)
Δsales(t-1)	.0083	.0081	.0090	.0089
	(0.0023)	(.0024)	(.0024)	(.0024)
k(*t*-2)	-.0092	-.0077	-.0082	-.0083
	(0.0018)	(.0019)	(.0018)	(.0018)
sales(t-2)	.0084	.0075	.0093	.0088
	(0.0016)	(.0017)	(.0017)	(.0018)
Long run interest rate (or user cost) elasticity	-0.043	-0.026	-0.061	-0.036
Number of obs	118	118	118	118
Adjusted R^2	0.9953	0.9952	0.9954	0.9933

Table 5. Investment and the rate of interest

The left hand side variable is firms' total fixed investment divided by the beginning of period book value of the net capital stock. The interest rate is the rate on the loans with the largest unused credit line (Interest Rate 1 from Table 2). All regressions include a full set of year dummies to account for common shocks and inflation. The first column shows the fixed effects estimator with no variable being instrumented; the second column shows the results when the interest rate is instrumented using only the first and second lag in the rate. The third column uses as instruments only bank characteristics. The core set of instruments includes bank size (measured as log total assets), the Herfindahl index on bank deposits and the bank's share of bad loans in agriculture. The full set of instruments used in the 4th column adds to the core set the share of bad loans to households, the ratio of labor cost to gross income, and the bank net position in the inter-bank market. The 5th column reports the Anderson & Hsiao first differenced estimator were the lagged investment-capital ratio is instrumented with the investment/capital ratio at lag three and log sales at lag 3, while the interest rate is instrumented with its first and second lag. The 6th column reports the Anderson & Hsiao estimates where the interest rate also has been instrumented using the bank characteristics in first difference, the investment/capital ratio at lag three and log sales at lag 3. Standard errors are reported in parentheses. (*) significant at less than 5%; (**) significant at less then 10%. Lower case letters denote logs and upper case denote levels.

	Level regressions				First difference estimator		
	OLS estimates	IV (only lagged rate)	IV (Core Bank characteristics)	IV Full set of bank characteristics	IV (Only lagged rate)	IV (Core Bank characteristics)	IV (Full set of bank characteristics)
Log(Int rate)	-.0093 (.0020)	.0620 (.0457)	-.0606 (.0370)**	-.0572 (.0294)*	.0504 (.0987)	-.0584 (.0370)**	-.0400 (.0285)
Δsales	.0810 (.0025)	.0820 (.0026)*	.0807 (.0025)*	.0806 (.0025)*	.0606 (.0049)*	.0625 (.0047)*	.0631 (.0048)*
Δsales(t-1)	.0892 (.0026)	.0911 (.0029)*	.0876 (.0028)*	.0876 (.0027)*	.0706 (.0121)*	.0729 (.0116)*	.0756 (.0114)*
k(t-2)	-.2018 (.0021)	-.1999 (.0023)*	-.2026 (.0022)*	-.2030 (.0022)*	-.2055 (.0648)*	-.2325 (.0627)*	-.2335 (.0619)*
sales(t-2)	.0841 (.0023)	.088 (.0033)*	.0813 (.0030)	.0819 (.0028)*	.0580 (.0181)*	.0598 (.0172)*	.0644 (.0169)*
I/*K*(t-1)	-0.1337 (.0031)	-.1344 (.0033)*	-.1344 (.0032)*	-.1350 (.0031)*	-.1951 (.0945)*	-.2335 (.0915) *	-.2493 (.0902)*
Long run interest rate elasticity	- .0461	0.310	-.2989 (.181)	-.281 (.144)	0.245 (.4919)	-.251	-.1642 (.118)
N. obs	136,739	132,782	136,457	135,921	78,318	77,172	76,633
N. of firms	29,893	29,174	29,079	29,845	19,110	18,906	18,849
Overall R^2	0.0297	0.0294	0.0297	0.0296	0.2757	0.2286	0.2475
Test of over identifying restrictions (*p*-value)		3.879 (.0489)	8.153 (.017)	18.392 (.0025)	.9457 (.1116)	5.026 (.170)	9.194 (.162)

Table 6. Investment and the rate of interest using alternative definitions

The left-hand side variable is firms' total fixed investment divided by the beginning of period book value of the net capital stock. In the first three columns interest rate 2 from Table 2 (the rate is the credit line with the least slack) is used; in the 4th-6th columns interest rate 3 from Table 2 (the highest rate paid by the firm) is used. All regressions include a full set of year dummies to account for common shocks and inflation. In the first and 4th columns the interest rate is instrumented using only two lags of itself. Core set of bank instruments include bank size (measured as log total assets), the Herfindahl index on bank deposits and the bank's share of bad loans in agriculture. The full set of instruments used in the third and 6th columns adds to the core set the share of bad loans to households, the ratio of labor cost to gross income, and the bank net position in the inter-bank market. Standard errors are reported in parentheses. (*) significant at less than 5%; (**) significant at less then 10%. Lower case letters denote logs and upper case denote levels.

	"Non-Marginal" Rate			"Maximum Rate Previously Paid"		
	Only lagged interest rate	Core bank instruments	Full set of bank instruments	Only lagged interest rate	Core bank instruments	Full set of bank instruments
Log(Int Rate)	.0350 (.0327)	.0144 (.0356)	-.0001 (.0303)	-.0273 (.0310)	-.0857 (.0335)*	-.0370 (.0283)
Δsales	.0817 (.0025)*	.0810 (.0025)*	.0809 (.0025)*	.0872 (.0030)*	.0889 (.0029)*	.0873 (.0034)*
Δsales(t-1)	.0902 (.0028)*	.0895 (.0028)*	.0891 (.0027)*	.0948 (.0030)*	.0956 (.0029)*	.0947 (.0028)*
k(t-2)	-.2007 (.0021)*	-.2014 (.0021)*	-.2017 (.0021)*	-.1991 (.0024)*	-.2013 (.0023)*	-.2009 (.0022)*
sales(t-2)	.0859 (.0029)*	.0849 (.0029)*	.0842 (.0028)*	.0878 (.0026)*	.0891 (.0025)*	.0889 (.0025)*
I/*K*(t-1)	-.1353 (.0031)*	-.1329 (.0031)*	-.1331 (.0031)*	-.1147 (.0036)*	-.1218 (.0034)*	-.1211 (.0034)*
Long run interest rate elasticity	0.1744 (.1632)	0.0716 (.1771)	-.0007 (.1498)	-.1372 (.1556)	-0.4258 (.1661)	-.1842 (.1407)
N. obs	132,759	136,554	136,059	101,828	117,582	117,147
N. of firms	29,172	29,885	29,848	20,914	26,090	26,057
Overall R^2	0.0296	0.0295	0.0294	0.0261	0.0281	0.0283
Test of over identifying restrictions (*p*-value)	10.002 (0.0066)	0.162 (0.9221)	8.124 (0.1495)	2.441 (.1182)	5.860 (.1186)	16.657 (0.0052)

Table 7. Investment and the user cost of capital

The left hand side variable is firms' total fixed investment divided by the beginning of period book value of the net capital stock. The user cost is computed using the interest rate on the largest unused credit line. All regressions include a full set of year dummies to account for common shocks and inflation. The first column shows the fixed effects estimator with the user cost instrumented only with the user cost net of the Tremonti at lags one and two to account for the endogeneity introduced by the Tremonti law. The core set of bank characteristics used as instruments includes: bank size measured by (log) total assets, the Herfindahl index on bank deposits and the bank's share of bad loans in agriculture. The full set of instruments adds to the core list the share of bad loans to households, the ratio of labor cost to gross income and the bank net position in the inter-bank market. The first three columns show estimates in levels. The remaining three columns report the Anderson & Hsiao first differenced estimator; the lagged investment-capital ratio is instrumented with the investment/capital ratio at lag three and log sales at lag 3. In the within estimates, the user cost is instrumented with the first difference in user cost net of the Tremonti at lags two and three. In the IV estimates it is instrumented with bank characteristics in first differences. Standard errors are reported in parentheses. (*) significant at less than 5%; (**) significant at less then 10%. Lower case letters denote logs and upper case denote levels.

	Level regressions			First difference estimates		
	IV (only lagged user cost)	IV (core bank instruments)	IV (full set of bank instruments)	IV (only lagged user cost)	IV (core bank instruments)	IV (full set of bank instruments)
Log(User Cost)	.0058 (.0447)	-.1766 (.0932)**	-.1976 (.0759)*	-.0121 (.1016)	-.2151 (.1007)*	-.1572 (.0832)**
Δsales	0.0866 (.003)*	.0784 (.0049)*	.0770 (.0042)	.0650 (.0057)*	.0616 (.0053)*	.0640 (.0050)*
Δsales(t-1)	.0955 (.0039)*	.0853 (.0059)	.0840 (.0051)*	.0806 (.0131)*	.07322 (.0126)*	.0792 (.0121)*
k(t-2)	-.1973 (.0029)*	-.1909 (.0041)*	-.1906 (.0041)*	-.2203 (.0659)*	-.2114 (.0630)*	-.2358 (.0613)*
sales(t-2)	.0882 (.0033)*	.0082 (.0048)*	.0808 (.0041)*	.0681 (.0195)	.0645 (.0185)	.0718 (.0180)*
I/*K*(t-1)	-.1094 (.0035)*	-.1119 (.0036)	-.1120 (.0034)*	-.2100 (.0953)*	-.2114 (.0905)	-.2427 (.0881)*
Long run user cost elasticity	0.030	-.9246 (.5055)	-1.0367 (.4138)	-.0818	-1.018 (.5557)	-0.667 (.381)
Test(χ^2) for long run elasticity =1 (*p*-value)	-	0.02 (.8818)	0.01 (0.9291)	2.97 (0.084)	0.00 (0.9747)	0.62 (0.4299)
N. obs	99,210	114,461	114,040	58,416	66,097	65,680
N. of firms	20,837	26,002	25,969	14,587	17,207	17,154
Overall R^2	0.0239	0.0325	0.0329	0.2448	.2357	0.2704
Test of over identifying restrictions (*p*-value)	14.396 (1.5e-04)	2.627 (.2689)	11.939 (.0356)	.1299 (.9371)	1.935 (.5859)	6.0099 (.4221)

Table 8. Investment and the user cost of capital: robustness to alternative interest rates

The left hand side variable is firms' total fixed investment divided by the beginning of period book value of the net capital stock. In the first three columns the user cost is user cost 2 from Table 2 (computed with the interest rate on the credit line with the least slack); in the 4th-6th columns user cost 3 from Table 2 (computed with the highest rate paid by the firm) is used. All regressions include a full set of year dummies to account for common shocks and inflation. In the first and 4th columns the user cost is instrumented using only the user cost (net of the tax credit granted by the Tremonti law) at lags one and two to account for the endogeneity introduced by the law. The core set of bank instruments includes bank size (measured as log total assets), the Herfindahl index on bank deposits and the bank's share of bad loans in agriculture. The full set of instruments used in the third and 6th columns adds to the core list the share of bad loans to households, the ratio of labor cost to gross income, and the bank net position in the inter-bank market. Standard errors are reported in parentheses. (*) Significant at less than 5%; (**) significant at less then 10%. Lower case letters denote logs and upper case denote levels.

	"Non-marginal interest rate"			"Maximum rate previously paid"		
	Only lagged user cost	Core bank instruments	Full set of bank instruments	Only lagged user cost	Core bank instruments	Full set of bank instruments
Log(User Cost)	.0916 (.0578)	.0155 (.1028)	.1970 (.1264)	.0224 (.0525)	-.04502 (.1728)	-.1355 (.0761)**
Δsales	.0912 (.0039)*	.0875 (.0052)*	.0956 (.0063)*	.0880 (.0032)*	.0853 (.0055)*	.082 (.0034*
Δsales(t-1)	.1006 (.0045)*	.0961 (.0064)*	.1059 (.0077)*	.0964 (.0036)*	.0934 (.0074)*	.0896 (.0041*
k(t-2)	-.2013 (.0036)*	-.1984 (.0049)*	-.2064 (.0058)*	-.1968 (.0030)*	-.1957 (.0071)*	-.1925 (.0037*
sales(t-2)	.0892 (.0030)*	.0902 (.0050)*	.0977 (.0059)*	.0892 (.0030)*	.0881 (.0056)*	.0833 (.0033*
I/*K*(t-1)	-.1088 (.0035)*	-.1158 (.0038)*	-.1190 (.0042)*	-.1088 (.0035)*	-.1143 (.0040)*	-.1134 (.0034)*
Long run user cost elasticity	0.4550 (.2815)	0.0783 (0.5162)	0. 9545 (0.5877)		-.2300 (.8908)	-.7041 (.4060)
Test(χ^2) for long run elasticity =1 (*p*-value)	-	3.98 (0.049)	9.36 (0.0022)	-	0.70 (0.4012)	0.52 (0.4712)
N. obs	99,426	114,776	114,386	105,689	114,065	113,53
N. of firms	20,842	26,014	25,977	24,149	26,009	25,976
Overall R^2	0.0212	0.0259	0.0200	0.0256	0.0286	0.0314
Test for over identifying restrictions (*p*-value)	7.376 (0.0066)	11.898 (.0077)	2.697 (.6098)		2.531 (.2821)	9.435 (0.0929

Table 9. Investment and the user cost of capital: robustness to an alternative specification

The left hand side variable is firms' total fixed investment divided by the beginning of period book value of the net capital stock. The user cost is computed using the interest rate on the largest unused credit line. All regressions include a full set of year dummies to account for common shocks and inflation. The first column shows the fixed effects estimator with the user cost instrumented only with the user cost net of the Tremonti at lags one and two to account for the endogeneity introduced by the Tremonti law. The (core) set of bank characteristics used as instruments includes: bank size measured by (log) total assets, the Herfindahl index on bank deposits and the bank's share of bad loans in agriculture. Standard errors are reported in parentheses. (*) significant at less than 5%; (**) significant at less then 10%. Lower case letters denote logs and upper case denote levels.

	Only lagged user cost	Bank instruments	
	IV	IV	IV
Log(User Cost)	.0992 (.0335)	-.1857 (.0917)*	-.1648 (.0569)**
CF/K_{t-1}	-	-	.0001 (.000026)*
N. obs	133,392	194,634	191,398
N. of firms	26,508	41,552	40,955
Overall R^2	0.0002	0.0207	0.0206
Test for over identifying restrictions (*p*-value)		5.246 (.0726)	4.518 (.1045)

Table 10. Robustness to the inclusion of cash flow and exclusion of large businesses

The left hand side variable is firms' total fixed investment divided by the beginning of period book value of the net capital stock. The user cost is computed using the interest rate on the largest unused credit line. All regressions include a full set of year dummies to account for common shocks and inflation. In the level estimates in columns one and three, the user cost is instrumented with the (core) set of bank characteristics: bank size measured by (log) total assets, the Herfindahl index on bank deposits, and the bank's share of bad loans in agriculture. In the first difference estimation, the lagged investment-capital ratio is instrumented using the investment/capital ratio at lag three and log sales at lag 3, while the user cost is instrumented with bank characteristics in first differences. Standard errors are reported in parentheses. (*) significant at less than 5%; (**) significant at less then 10%. Lower case letters denote logs and upper case denote levels.

	Including cash flow		Excluding large businesses (firm with employees>80)	
	IV (level regressions)	IV (first difference)	IV (level regressions)	IV (first difference)
Log(User Cost)	-.1429 (.0861)**	-.2010 (.1025)*	-.1998 (.1667)	-.1393 (.1494)
Δsales	.0707 (.0050)*	.0625 (.0053)*	.07518 (.0046)*	0.0740 (0.0087)*
$\Delta sales_{t-1}$	.0873 (.0055)*	.0758 (.0126)*	.0884 (.0053)*	.0981 (.0216)*
k_{t-2}	-.1915 (.0042)*	-.2162 (.0636)*	-.2557 (.0064)*	-.3744 (.1243)*
$sales_{t-2}$	.0829 (.0048)*	.0678 (.0187)*	.0865 (.0062)*	.1024 (.0317)*
$(CF/K)_{t-1}$	.0002 (.0001)*	-.0003 (.0003)	-	-
I/K_{t-1}	-.1429 (.0036)*	-.2193 (.0917)*	-.2153 (.0054)*	-.3957 (.1666)*
Long run user cost elasticity	-0.747 (.4091)	-0.930 (.5338)	-0.781 (.6613)	-0.372 (.4184)
Test(χ^2) for long run elasticity =1 (*p*-value)	0.24 (0.6219)	0.02 (0.8967)	0.11 (0.7419)	1.46 (0.2275)
N. obs	111,316	64,702	48,822	23,562
N. of firms	25,413	16,867	15,397	9,981
Overall R^2	0.0316	0.2442	0.0265	0.3106
Test for over identifying restrictions (*p*-value)	9.590 (.0479)	1.279 (.734)	2.427 (.971)	2.356 (.5118)

Table 11. Addressing liquidity constraints

The left hand side variable is firms' total fixed investment divided by the beginning of period book value of the net capital stock. The user cost is computed using the interest rate on the largest unused credit line. All regressions include a full set of year dummies to account for common shocks and inflation. High cash-flow firms are those whose average ratio between gross operating profits and interest payments over the years they are in the sample, divided by its standard error, is above median. The set of bank characteristics used as instruments includes: bank size measured by (log) total assets, the Herfindahl index on bank deposits and the bank share of bad loans in agriculture. Likely liquidity constrained firms are those which have a value of the ratio of total utilized loans to total granted loans greater than the 80th percentiles of the empirical distribution. (*) significant at less than 5%; (**) significant at less then 10%. Lower case letters denote logs and upper case denote levels.

	High standardized cash-flow firms		Likely liquidity- constrained firms	
	IV – levels (bank instruments)	IV- First difference	IV	IV- First difference
log(User Cost)	-.2560 (0.1222)*	-.2184 (.1344)**	-.2670 (.1647)**	-.2628 (.1624)**
Δsales	.0836 (.0066)*	.0634 (.0083)	.0610 (.0107)*	.0469 (.0144)
Δsales(t-1)	.0959 (.0080)*	.0678 (.0194)	.0527 (.0117)*	.0489 (.0321)
k(t-2)	-.2075 (.0058)*	-.1735 (.0912)	-.2339 (.0094)*	-.2291 (.1771)
sales(t-2)	.0896 (.0064)*	.0446 (.0300)	.0553 (.0113)*	.0432 (.0478)
I/*K*(t-1)	-.1174 (.0050)*	-.1388 (.1248)	-.1712 (.0088)*	-.2325 (.2455)
Long run user cost elasticity	-1.234 (.6188)	-1.256 (.986)	-1.141 (.738)	-1.147 (1.111)
Test(χ^2) for long run elasticity =1 (*p*-value)	0.15 (0.7028)	0.08 (0.7754)	0.56 (0.4552)	0.02 (0.8860)
N. obs	59,691	35,623	21,940	12,705
N. of firms	13,103	8,853	10,337	6,304
Overall R^2	0.0325	0.1938	0.0287	0.2433
Test for over identifying restrictions (*p*-value)	1.372 (.5035)	2.124 (.5470)	0.142 (.9316)	0.965 (0.810)

Table A1. Population and CB sample marginal frequency distribution by firms' size, sector of activity and geographical location in 1990

	Marginal frequency distribution	
	Population (1990 Census)	Sample
Firms size (number of employees)		
50 – 99	22.7	15.0
100-199	20.2	16.9
200-499	21.3	19.7
500-999	17.5	12.0
>999	18.3	36.4
Geographical location (regions)		
Piemonte and Valle d'Aosta	12.7	14.9
Lombardia	33.8	36.6
Liguria	2.5	3.9
Trentino Alto Adige	1.1	1.1
Veneto	8.9	9.3
Friuli Venezia Giulia	2.4	3.5
Emilia Romagna	10.1	9.1
Toscana	6.3	4.5
Umbria	1.6	1.1
Marche	2.4	2.1
Lazio	3.4	4.8
Abruzzi	2.1	1.4
Molise	0.6	0.1
Campania	3.9	3.7
Puglia	2.0	1.3
Basilicata	0.4	0.3
Calabria	0.6	0.2
Sicilia	1.9	1.3
Sardegna	3.2	0.7

Population and sample refer to firms with more than 50 employees.