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Investment and monetary policy in the euro area

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Abstract

This paper analyses the effects of a change in monetary policy on firms' investment in Germany, France, Italy and Spain using a data set which provides aggregated balance sheet and profit and loss account data for 17 different industries and three different size classes. The main findings are twofold. First, in each of the four countries a change in the user cost of capital, which in turn is affected by interest rates, has both statistically and economically significant effects on investment. Second, while the average interest rate on debt is generally higher for small firms than for large firms, there is little evidence that the effects of monetary policy on small firms are larger.

JEL classification: E52
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1. Introduction

A good understanding of the monetary transmission mechanism in the euro area is essential for the efficient implementation of the ECB's single monetary policy. While there is a large literature which focuses on the macroeconomic effects of a change in policy-controlled interest rates in the various euro area countries (Kieler and Saarenheimo, 1998), much less comparative work has been done based on microeconomic evidence. Nevertheless, such evidence is important for at least two reasons. First, it has proven to be very difficult to find significant interest rate effects on investment using aggregate data (Blanchard, 1986). Using the cross-sectional variation

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in disaggregated data, it may be easier to empirically identify such interest rate effects. For the euro area there is hardly any microeconomic evidence on the elasticity of investment with respect to the user cost of capital. [2] Most of the studies that estimate Euler equations of investment postulate a production function that is homogenous of degree one and therefore impose a unit elasticity without testing it. [3] Second, it has been argued that differences in financial systems could lead to asymmetries in the transmission as some countries are more affected by financial accelerator phenomena than others. [4] Typically, such transmission channels imply that monetary policy has distributional effects, which can only be tested using disaggregated data.

In this paper we analyse industry-specific investment behaviour in the four largest countries of the euro area (i.e. Germany, France, Italy and Spain) using a semi-aggregate data set on firms' balance sheets assembled by the European Commission. The data comprises 17 industries (both manufacturing and services) for each country. For each industry we have disaggregated balance sheet information for three different firm-size classes bringing the total number to 51 "representative industries". Starting from a neoclassical model for investment, we first examine the elasticity of investment with respect to the user cost of capital, we then examine the effects of an interest rate change on the user cost of capital. Finally, we also study to what extent the strength of the effect of monetary policy on industry investment is related to the size of the firms within the industry.

The contribution of this paper is threefold. First, we use a consistent data set and methodology to estimate investment equations for the four largest countries of the euro area. This increases the comparability of the results across countries. Moreover, these four countries cover around 80% of total euro area GDP. Second, while most studies that estimate the effect of changes in the user cost of capital on investment focus on variations in tax rates, this paper is the first one to use a time and industry varying interest rate on debt to build firm-specific measures of the user cost of capital. We find a significant negative effect of the user cost on investment in all four countries. While the short-term dynamics differs across countries, it is striking that the long-run parameters are quite similar. The long-run elasticities of the capital stock with respect to both sales and the user cost are not significantly different from 1, implying that a simple Cobb–Douglas specification of the production function cannot be rejected. This result is in stark contrast with the large literature on aggregate investment functions (Blanchard, 1986) and with one of the major arguments of proponents of the credit channel that the empirical evidence on a sizable impact of the user cost on investment is very weak (Bernanke and Gertler, 1995). Our results

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[2] For example, Bond and Van Reenen (1999) note that "Compared to the voluminous literature on financing constraints and investment there has been a dearth of microeconomic studies that focus on estimating the sensitivity of investment to changes in taxes, interest rates or other compounds of the user cost of capital".

[3] See Mojon (2000) for a survey of the empirical literature on investment and liquidity constraints in the euro area.

[4] See, for example, BIS (1995), Kashyap and Stein (1997) and Guiso et al. (1999).

are in line with the conclusion of Hasset and Hubbard (1997) that recent empirical research on the sensitivity of investment to the user cost with microdata has resulted in substantial estimates of the elasticity ranging from −0.5 to −1. [5] While these studies refer to the US economy, we show that the long-run elasticity of the capital stock with respect to the user cost also fall in this range for the four largest countries of the euro area.

Third, we are one of the few studies to use microlevel data to test whether, as suggested by the credit channel, the external finance premium paid by small firms reacts to changes in monetary policy. [6] While there is a relatively large literature which tests the effects of financing constraints on investment in countries of the euro area, only a few studies directly address to what extent liquidity constraints interact with the stance of monetary policy. [7] In this paper, we use firm-specific interest rates to examine financial accelerator phenomena. Although we find that the interest rate paid by small firms is on average higher than that paid by larger firms, we do not find evidence that it is also more sensitive to changes in market interest rates. Similarly, the investment by small firms does not appear to be more sensitive to changes in the user cost of capital. These two results cast some doubt on whether the financial accelerator has played an important role in the link between interest rate changes and investment in Germany, France, Italy and Spain over the sample period.

The rest of the paper is structured as follows. In the next section we briefly describe the model we estimate. We follow the derivation of a neoclassical investment model as in Hall et al. (1999). In Section 3 we describe the data we use. We also explain how we construct our measure of the user cost of capital and describe the other variables used in the regressions. Section 4 contains the main estimation results. First, we report the estimate of the basic neoclassical investment model. Next, we analyse how the firm-specific interest rates are affected by changes in market interest rates. Finally, we test whether the elasticity of investment with respect to the user cost of capital depends on the size of the firms. Finally, we present the main conclusions in Section 5.

2. Estimation methodology

In order to estimate the effects of a change in interest rates on firms' investment we proceed in two steps. In the first step we estimate a dynamic neoclassical investment

[5] See also Chirinko et al. (1999) and Cummins et al. (1994).

[6] For instance, Gertler and Gilchrist (1993) suggest that the monetary transmission may work through unequal access of large and small firms to external finance after adverse monetary policy shocks. See also Vermeulen (2000) for a recent empirical investigation of the effects of the business cycle on the external financial premium of small firms and large firms in the euro area.

[7] Examples of papers that analyse the interaction of the effects of liquidity constraints on investment with the stance of monetary policy in countries of the euro area are Crépon and Rosenwald (2000), Rondi et al. (1998), Wesche (2000) and Beaudu and Heckel (2001). Hu (1999) is one study that directly analyses the effects of monetary policy on firms' investment in the United States using a panel data approach.

model which links investment to sales and, more importantly, the user cost of capital. In the second step, we analyse the sensitivity of the firm-specific interest rate component of the user cost of capital to changes in short- and long-term interest rates. In both steps we also test whether the sensitivity of investment to the user cost and the sensitivity of the user cost to changes in interest rates differs across firms of different size. The hypothesis to be tested is that smaller firms are subject to greater informational problems and are thus affected more strongly by a monetary policy tightening.

Our basic specification for explaining firms' investment in the first step is a version of the dynamic neoclassical investment model as, for example, discussed and estimated in Hall et al. (1999) and Bond et al. (1997). This specification is a dynamic version of a neoclassical CES-production function model that implies that in the long run there is a relationship between the level of the capital stock, the level of sales and the user cost of capital:

$$k_{i,t} = \theta_t + \beta s_{i,t} - \sigma \mathrm{uc}_{i,t} \tag{1}$$

where the subscripts denote industry i and year t, $k_{i,t}$ is the log of the real capital stock, $s_{i,t}$ is the log of real sales and $\mathrm{uc}_{i,t}$ is the log of the real user cost of capital. θ_t is a time-varying productivity parameter, β is the long-run elasticity of capital to sales and σ is the long-run elasticity of capital to the user cost. If the underlying production function is of the constant-returns-to-scale Cobb–Douglas type both long-run elasticities will be equal to one.

We follow Hall et al. (1999) and Bond et al. (1997) and specify a dynamic adjustment mechanism between k, s, and uc as an autoregressive-distributed lag of length two, [8] written in error correction form,

$$\begin{aligned}\Delta k_{i,t} = {} & \eta_t + \alpha_1 \Delta k_{i,t-1} + \alpha_2 \Delta s_{i,t} + \alpha_3 \Delta s_{i,t-1} + \alpha_4 \Delta \mathrm{uc}_{i,t} + \alpha_5 \Delta \mathrm{uc}_{i,t-1} + \alpha_6 k_{i,t-2} \\ & + \alpha_7 s_{i,t-2} + \alpha_8 \mathrm{uc}_{i,t-2}.\end{aligned} \tag{2}$$

However, Hall et al. (1999) and Bond et al. (1997) deviate substantially from our study in that they do not use a measure of the user cost and therefore replace it with time dummies and fixed effects. In Eq. (2), α_2 to α_5 capture the short-run effects of sales and the user cost on the capital stock. α_6 captures the speed of adjustment of investment to deviations of the capital stock from its long-run desired level as given in Eq. (1). The long-run elasticities are given by $\beta = -\alpha_7/\alpha_6$ and $\sigma = -\alpha_8/\alpha_6$.

Finally, using the relationship between the net growth rate of the capital stock ($\Delta k_{i,t}$) and the gross investment ratio ($\mathrm{IK}_{i,t}$) and the depreciation rate (δ_i), ($\Delta k_{i,t} = \mathrm{IK}_{i,t} - \delta_i$), we obtain the basic specification estimated in this paper:

$$\begin{aligned}\mathrm{IK}_{i,t} = {} & \eta_t + \gamma_i + \alpha_1 \mathrm{IK}_{i,t-1} + \alpha_2 \Delta s_{i,t} + \alpha_3 \Delta s_{i,t-1} + \alpha_4 \Delta \mathrm{uc}_{i,t} + \alpha_5 \Delta \mathrm{uc}_{i,t-1} \\ & + \alpha_6 k_{i,t-2} + \alpha_7 s_{i,t-2} + \alpha_8 \mathrm{uc}_{i,t-2} + \varepsilon_{i,t}.\end{aligned} \tag{3}$$

[8] In principle one could allow for more lags than two. However, this leads to a degree of freedom loss in estimation.

η_t is a time-specific fixed effect which may capture aggregate developments in productivity, while γ_i is an unobserved industry fixed effect which may capture industry-specific depreciation rates. [9] $\varepsilon_{i,t}$ is a serially uncorrelated error term which is also uncorrelated with all past variables.

This specification of the neoclassical model is preferred over the Euler specification, basically for its simplicity. This is of importance given the limited size of our data set. [10] The additional structure that the Euler approach imposes is often rejected by the data. For instance, the adjustment cost function is usually imprecisely estimated. [11]

We estimate Eq. (3) using two different estimators. [12] First, we use the WITHIN estimator. The WITHIN estimator accounts for the fixed industry effects by using least squares on the deviations of all variables to their industry means (that is implicitly including industry dummies). In addition, we account for the time effects by explicitly including a full set of year dummies in all the regressions. The WITHIN estimator may suffer from two possible biases. The first one is due to the presence of the lagged dependent variable. [13] As this bias falls as the sample period lengthens, it is likely to be very small given the relatively long length T of our data set. The second bias is due to the endogeneity of contemporaneous sales growth and changes in the user cost. This may call for an instrumental variable estimator. We therefore also present results with the orthogonal deviations (OD) estimator developed in Arellano and Bover (1995). This is a GMM estimator in which each observation is expressed as its deviation from the average of future observations in the sample for the same industry. The level variables lagged two and earlier can then be used as instruments. [14]

In order to make the link with monetary policy, we investigate in the second step the sensitivity of the industry-specific (nominal) interest on debt to changes in short- and long-term interest rates by estimating the following regression:

$$\Delta \mathrm{ID}_{i,t} = \pi_0 + \pi_1 \Delta i_t + \pi_2 \mathrm{ID}_{i,t-1} + \pi_3 i_{t-1} \tag{4}$$

[9] Note that we use "industry" here loosely. Each of the 51 "representative industries" has a fixed effect, not only each of the 17 industries.

[10] We cannot follow Tobin's Q approach because we do not have the market value of the firms included in the aggregate balance sheet items.

[11] The studies that estimate an Euler equation for a panel of firms within countries of the euro area typically have difficulties in obtaining a convex adjustment cost function. See Mojon (2000) for a survey.

[12] For a more thorough discussion of the advantages and disadvantages of the various estimators in this kind of model, see Hall et al. (1999). All estimations are performed using DPD98 for Gauss written by M. Arellano and S. Bond.

[13] This bias arises because of the correlation of the lagged investment capital ratio with the past and current values of the ideosyncratic disturbances. See Nickell (1981).

[14] We also experimented with the Arellano–Bond first difference-GMM estimator. However, the coefficients turned out to be very imprecisely estimated. This was mainly due to difficulties in finding good instruments for the difference in the change of the user cost. We also suspect measurement error to be a problem in the first difference estimator, as measurement error is exacerbated when taking first differences rather than differences from means. Ziliak (1997) has argued that OD may offer efficiency gains over first differences when measurement error is present. This may explain why OD works better in our case.

where i_t is the short- or long-term nominal interest rate and $\mathrm{ID}_{i,t}$ is the average interest paid on debt by industry i. The long-run effect of a change in the interest rate on the average interest rate on debt is given by $-\pi_3/\pi_2$.

Finally, in order to test whether monetary policy has heterogenous effects across different size classes, we also interact the user cost in Eq. (3) and the interest rate in Eq. (4) with size dummies. The hypothesis that smaller firms are subject to greater informational problems and are thus affected more strongly by a monetary policy tightening can be tested in our data set. The big advantage of the size criterion is that it can safely be treated as exogenous to the balance sheet of the industry, so that no simultaneity problems arise. A more direct test of the broad balance sheet channel of monetary policy would be to analyse whether the interest rate effects are stronger in industries with "weak" balance sheets. However, most indicators of the strength of the balance sheet position such as the coverage ratio or leverage will be endogenously determined with the average interest rate on debt.

3. The data

3.1. The BACH-database

The BACH-database from the European Commission contains aggregated yearly balance sheet and profit and loss account information for 17 different sectors and three size classes of firms. It covers 11 European countries for a period from the early 1980s to the mid-1990s. A unit of observation is defined by country, size and sector. For instance, large German firms in the food, drink and tobacco sector is one observational unit; small French firms in the chemical and man-made fibers industry is another. The number of firms used in the aggregation usually differs from year to year, but in general it is quite large. For instance, for Germany it is around 19,000 firms employing around 3,500,000 employees, for Italy it is around 27,000 firms employing 2,600,000 employees. Before the aggregation takes place, the accounting data are harmonised across countries in a single format. Therefore, each industry has one aggregated balance sheet and one profit and loss account that should be relatively comparable across countries.

In this paper we focus on the 10 manufacturing industries present in BACH, construction and up to six trade and services sectors. [15] The three size classes are: small firms (turnover of less then 7 million ECU), medium-sized firms (turnover between 7 and 40 million ECU) and large firms (turnover in excess of 40 million ECU). An important advantage of this database is the inclusion of very small firms. For instance, for Germany, the firms used for aggregation in the small firms size class have on av-

[15] The sectors are three intermediate goods sectors, three investment goods sectors, four consumption goods sectors, building and civil engineering, wholesale trade, sales of motor vehicles, retail trade, hotels–restaurants, transport and communication and other services. See the Appendix for a full list.

erage around 30 employees for the manufacturing sectors and around 12 employees for the services sectors. For the other countries similar numbers hold.

Unfortunately, the use of the data for cross-country comparison is severely hampered by the fact that for many countries many items are not available (i.e. left blank in the database). Because of this reason, in this paper only the information on Germany, France, Italy and Spain could be used. [16] Only these countries provide enough information on the variables used in this study. Fortunately, these countries represent a large part of euro-area wide business investment. Also the length of the sample differs across countries. It is shortest for Germany covering annual data from 1988 to 1997 and longer for France (1985–1998), Italy (1983–1998) and Spain (1983–1998). The details of how the individual variables were constructed can be found in the Appendix.

3.2. Definition of the user cost of capital

Following the original contribution by Hall and Jorgenson (1967), we construct the user cost of capital as

$$\mathrm{UC}_{i,t} = \frac{P_{I,i,t}}{P_{i,t}}\left((1-\tau)\mathrm{ID}_{it}\frac{D_i}{D_i+E_i} + l_t\frac{E_i}{D_i+E_i} + \delta_i - (1-\delta_i)\frac{\Delta P_{I,it+1}}{P_{I,t}}\right) \tag{5}$$

where $\mathrm{UC}_{i,t}$ is the level of the user cost, $P_{I,i,t}$ and $P_{i,t}$ are respectively the industry specific prices of investment goods and output. The term in brackets consists of three parts: $(1-\tau)\mathrm{ID}_{i,t}[D_i/(D_i+E_i)] + l_t[E_i/(D_i+E_i)]$ is the industry-specific required rate of return on capital, δ_i is the depreciation rate and $(1-\delta_i)(\Delta P_{I,it+1}/P_{I,t})$ the capital gain on the fraction of capital left over after depreciation. The industry-specific required rate of return, is defined by a weighted average of the required return on equity, which we capture by the nominal long-term interest rate l_t, and the average interest rate paid on debt, ID_{it} allowing for tax deduction of interest paid, τ being the highest marginal tax rate on corporate profits. [17] The weights used are respectively the average percentage of equity finance $E_i/(D_i+E_i)$ and the average percentage of debt finance $D_i/(D_i+E_i)$ in the particular industry. Naturally, the weights sum to one.

Our measure of the interest rate component of the user cost has two main drawbacks. First, the long-term interest rate on bonds is a poor proxy for the required return on firms' equity. However, we prefer not to base this required return on the stock market yield. Our data set contains many firms that are too small to be traded, at least in continental Europe where market finance is still underdeveloped. As a result, the stock market return is unlikely to reflect the return requirement on these firms. Second, the average interest rate on debt is only a proxy for the expected marginal interest rate the firm needs to pay on new loans, which enters the true user cost.

[16] Since BACH only contains West-German firm data, all numbers used in this paper are based on West-German data only.

[17] See the data appendix for the construction of the data series used.

Unfortunately, this expected marginal interest rate is not observable. We choose to use the firm specific apparent interest rate rather than a market based interest rate in order to exploit the cross-industry variation. That the apparent interest rate may contain useful cross-sectional information is suggested by the fact that small firms do pay a higher cost for their external debt (see next section). [18]

3.3. Investment, the user cost of capital and balance sheet indicators

Table 1 contains a brief description of the dataset. It compares, both across size classes and across countries, the ratio of investment to capital (IK_{it}), sales growth (Δs_{it}), the level (not the log) of the user cost of capital (UC_{it}) and the average interest rate on debt (real ID_{it}). It also contains two variables used to explain differences across size classes in average interest rates on debt: the ratio of land and building to capital (BK_{it}) as a measure of collateral and short-term debt on total debt (SD_{it}) as a measure of the maturity of debt. [19]

As the standard deviation indicate, the variability of these variables across sectors within each country and each size is very high. However, some of the differences across size classes are quite instructive. We observe first that with the exception of Italy, small or medium-sized firms tend to invest more than large firms. Overall, small firms tend, with the exception of Germany, to use more short-term debt than large firms. Finally, the average interest rate on debt is larger for smaller firms. This finding corresponds with other evidence that smaller firms generally need to pay a higher risk premium. [20] While this may be an indication that smaller firms face larger informational problems, it may also be the result of the fact that smaller firms are generally more risky firms.

This finding is confirmed by the more formal regression results reported in Table 2. The first regression of Table 2 shows that small firms pay statistically and economically a significantly higher average interest on their debt than large firms. Even in Germany, the country with the smallest difference between large and small firms, the difference is still 75 basis points. In Italy, also medium sized firms pay significantly more than large firms. The second regression reported in Table 2 tests whether this could be due to differences in maturity structure. The results show that even accounting for differences in maturity structure, small firms pay significantly more than large firms. Somewhat surprisingly, a shorter maturity structure implies a higher average interest rate in Italy and Spain. This may indicate that firms with a low credit

[18] To check robustness, we also run our investment regressions with the real long-term interest rate as our measure of the required rate on capital. The results are not significantly affected.

[19] The median and standard deviation for each size class are based on 272 observations for either Italy or Spain (16 periods times 17 sectors), 238 for France (14 periods times 17 sectors) and 130 for Germany (10 periods times 13 sectors).

[20] See for instance the survey conducted by Banque de France on the cost of bank loans according to size or Angeloni et al. (1994) for comparable evidence in Italy.

Table 1
Median balance sheet structures in Germany, France, Italy and Spain

		Germany		France		Italy		Spain	
		Median	Std. dev.	Median	Std. dev.	Median	Std. dev.	Median	Std. dev.
IK	Total	0.29	0.08	0.25	0.07	0.20	0.08	0.16	0.08
	Large	0.27	0.07	0.22	0.08	0.20	0.09	0.15	0.08
	Medium	0.29	0.07	0.25	0.07	0.21	0.07	0.16	0.08
	Small	0.30	0.08	0.26	0.07	0.17	0.08	0.16	0.07
Δs	Total	0.04	0.06	0.02	0.05	0.03	0.09	0.04	0.07
	Large	0.04	0.05	0.02	0.05	0.06	0.07	0.04	0.08
	Medium	0.04	0.06	0.02	0.05	0.05	0.07	0.05	0.07
	Small	0.02	0.07	0.00	0.05	−0.04	0.09	0.04	0.07
UC	Total	0.23	0.03	0.22	0.04	0.17	0.04	0.14	0.03
	Large	0.24	0.03	0.21	0.05	0.18	0.04	0.14	0.04
	Medium	0.23	0.02	0.22	0.04	0.17	0.04	0.15	0.03
	Small	0.24	0.02	0.23	0.04	0.15	0.04	0.14	0.03
Real ID	Total	0.04	0.01	0.05	0.02	0.04	0.02	0.03	0.03
	Large	0.04	0.01	0.04	0.02	0.03	0.02	0.03	0.02
	Medium	0.04	0.01	0.05	0.02	0.04	0.02	0.03	0.02
	Small	0.05	0.01	0.05	0.02	0.06	0.02	0.04	0.03
BK	Total	0.18	0.06	0.16	0.13	na	na	0.24	0.14
	Large	0.20	0.06	0.17	0.15	na	na	0.22	0.12
	Medium	0.20	0.06	0.15	0.12	na	na	0.24	0.16
	Small	0.15	0.06	0.15	0.11	na	na	0.27	0.13
DA	Total	0.63	0.16	0.66	0.08	0.66	0.07	0.57	0.10
	Large	0.42	0.12	0.63	0.09	0.64	0.08	0.57	0.12
	Medium	0.61	0.08	0.65	0.08	0.66	0.07	0.57	0.10
	Small	0.74	0.06	0.66	0.07	0.66	0.07	0.58	0.09
SD	Total	0.69	0.09	0.50	0.10	0.70	0.09	0.69	0.14
	Large	0.75	0.10	0.46	0.11	0.69	0.11	0.65	0.16
	Medium	0.69	0.06	0.52	0.08	0.71	0.08	0.72	0.13
	Small	0.62	0.05	0.51	0.10	0.69	0.08	0.70	0.12

Source: Authors' calculation based on BACH. Medians and standard deviation over time and across firms for the total sample and for each size class of: investment capital ratio (IK), growth rate of sales (Δs), the user cost of capital (UC), the ratio of land and building to capital (BK), the real apparent interest rate on debt (real ID), the ratio of total debt on total asset (DA) and the ratio of short-term debt to total debt (SD). See the appendix for the definition of the variables. Time periods vary across countries: 1983–1998 for Italy and Spain, 1985–1998 for France and 1988–1997 for Germany. The mean and standard deviation for each size class are based on 272 observations for either Italy or Spain (16 periods times 17 sectors), 238 for France (14 periods times 17 sectors) and 130 for Germany (10 periods times 13 sectors).

standing are forced to finance primarily through short-term debt at high interest rates. The third regression tests whether there are differences in the cost of debt across sizes after controlling for differences in collateral. Again, the small firm effect remains. We also find, for France and Spain, that firms with a higher share of collateralisable assets on average pay less on their debt. Only when controlling jointly

Table 2
Determinants of the cost of debt

	Germany		France		Italy		Spain	
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
CONST	3.84	0.22	4.43	0.26	3.28	0.31	2.22	0.22
Small	0.73	0.25	0.79	0.39	2.22	0.50	0.98	0.43
Medium	0.33	0.25	0.50	0.43	0.99	0.43	0.63	0.37
CONST	4.38	1.03	3.65	1.38	−2.91	1.67	−1.46	0.84
Small	0.65	0.27	0.73	0.37	2.35	0.46	0.83	0.39
Medium	0.29	0.25	0.40	0.43	1.00	0.43	0.43	0.35
SD_i	−0.72	1.43	1.69	2.97	8.93	2.49	5.71	1.32
CONST	4.19	0.52	5.15	0.35	na	na	3.38	0.43
Small	0.66	0.28	0.72	0.36	na	na	1.15	0.39
Medium	0.32	0.25	0.45	0.39	na	na	0.80	0.35
BK_i	−1.75	1.95	−3.47	1.69	na	na	−4.55	1.31
CONST	6.57	1.37	7.05	1.96	na	na	−0.43	1.53
Small	0.26	0.32	0.83	0.38	na	na	0.91	0.40
Medium	0.15	0.24	0.64	0.43	na	na	0.51	0.38
BK_i	−3.71	2.23	−5.00	2.20	na	na	−1.38	1.71
SD_i	−2.66	1.48	−3.43	3.73	na	na	4.66	1.87

Source: Authors' calculation. The dependent variable is the firms' mean over time of the ratio of interest payment on total debt (ID_i). It is regressed on a constant, and, successively, on dummy variables for size classes (Small and Medium), firms' mean over time of short-term debt on total debt (SD_i), and the firms' mean over time of collateralizable assets (BK_i) (land and buildings as a fraction of total fixed assets).

for collateral and maturity, the small firm effect disappears in Germany. Overall, these results suggest that size has an independent effect on a firm's interest rate and that it may indeed be useful to use size as an indicator to test for credit channel effects.

A graphical inspection of the data would actually give an impression of the cyclical behaviour of the investment capital ratio, sales growth, the user cost and the average interest rate on debt in each of the four countries. [21] Although there is quite some cross-industry variation, there is a clear cyclical pattern in the overall behaviour of investment and sales growth. For example, in each of the countries the investment capital ratio fell in the early 1990s as the economy went through a recession. One can also observe that the cross industry variation is higher in Italy and Spain than in Germany and France. The time variation in the user cost is less pronounced. However, the effects of the ERM crisis in the early 1990s is evident in a rise of the real cost of debt and on the user cost in that period in France, Italy and Spain.

[21] These graphs are available in the working paper version of the paper. See the European Central Bank working paper series 78 on "www.ecb.int".

4. Results

4.1. The dynamic neoclassical model

Table 3 reports the regression results of the basic specification (3) for each of the four countries. For completeness, Table 3 also reports the regression results when we pool the country data. [22] However, the hypothesis that all the parameters of the model are equal across countries is strongly rejected (the P-value of the F test against a specification with country-specific coefficients is of the order of 10E−8). As discussed below, this appears to be mostly due to the significant differences in the parameters capturing the short-run dynamics. The first panel reports the WITHIN estimates and the second panel the OD estimates. For each set of estimates, we compute the long-run elasticities of capital with respect to sales and to the user cost of capital. The standard error of these elasticities is derived with the delta method.

A number of interesting features can be observed. [23] First, the long-run elasticities of the real capital stock with respect to sales and the user cost do not appear to be significantly different from one in all of the countries, except for the OD estimates in Germany. Pooling the observation of the four countries, we obtain an elasticity of −0.90 for the user-cost and of 0.98 for sales with the WITHIN and respectively −1.20 and 0.78 for respectively the user cost and sales with the OD. These estimates indicate that a Cobb–Douglas specification of the production function is not rejected by the data. [24] According to our knowledge this is the first study to show a close to unity user cost elasticity of capital on the basis of cross-industry variations in the average interest rate on debt. As mentioned in the introduction this finding is consistent with the literature which has identified changes in the user cost of capital based on tax rates (Hasset and Hubbard, 1997). Our estimates are close to the upper bound for the effect of user cost as found by this other literature. It is also consistent with the findings of Caballero et al. (1995), which uses time series econometrics on historical data.

Second, in all countries the coefficient α_6, which captures the adjustment towards the long-run desired capital stock is negative and significant. This further confirms that an error correction mechanism, of the kind proposed by Bond et al. (1997) and Hall et al. (1999) is appropriate to model investment demand in each of the four countries we look at. Notice that the speed of adjustment is highest in Germany. However, if we estimate the model for France, Italy and Spain over the same sample as Germany, these differences are somewhat reduced.

[22] In this case, the estimates are carried out with country-specific time dummies.

[23] To check robustness we also estimated the basic specification (3) for France, Italy and Spain over the same sample as Germany. Overall, the results highlighted below continue to hold. These results are available upon request.

[24] This result is robust to variations in the definition of the user cost of capital. For instance, the result also holds when defining the interest rate part of the user cost as equal to the long-term bond rate or as equal to the firm-specific interest rate on debt.

Table 3
Error correction form of an accelerator model of investment

		Within estimates									
		Germany		France		Italy		Spain		Pooled	
		Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
$IK_{i,t-1}$	$\alpha1$	0.03	0.06	0.12	0.04	0.00	0.04	0.22	0.04	0.12	0.02
$\Delta s_{i,t}$	$\alpha2$	0.12	0.07	0.25	0.05	0.15	0.03	0.13	0.04	0.14	0.02
$\Delta s_{i,t-1}$	$\alpha3$	0.29	0.07	0.16	0.05	0.11	0.03	0.05	0.04	0.10	0.02
	$\alpha2+\alpha3$	0.41		0.41		0.26		0.18		0.23	
$\Delta uc_{i,t}$	$\alpha4$	−0.24	0.12	−0.08	0.05	−0.08	0.03	−0.28	0.05	−0.13	0.02
$\Delta uc_{i,t-1}$	$\alpha5$	−0.34	0.12	0.07	0.05	−0.01	0.03	−0.10	0.05	−0.03	0.02
	$\alpha4+\alpha5$	−0.58		−0.01		−0.09		−0.38		−0.16	
$k_{i,t-2}$	$\alpha6$	−0.13	0.03	−0.04	0.01	−0.06	0.01	−0.06	0.01	−0.06	0.01
$s_{i,t-2}$	$\alpha7$	0.16	0.04	0.04	0.01	0.05	0.01	0.06	0.01	0.05	0.01
$uc_{i,t-2}$	$\alpha8$	−0.09	0.06	−0.03	0.03	−0.05	0.02	−0.05	0.04	−0.05	0.02
Rsquare		0.50		0.48		0.43		0.37		0.43	
	Long-run elasticities of capital with respect to										
Sales	$\alpha7/\alpha6$	1.24	0.19	1.08	0.35	0.84	0.11	1.07	0.16	0.98	0.08
User cost	$\alpha8/\alpha6$	−0.68	0.45	−0.75	0.74	−0.83	0.35	−0.88	0.59	−0.90	0.25
		OD estimates									
$IK_{i,t-1}$	$\alpha1$	−0.16	0.13	0.15	0.11	−0.01	0.11	0.42	0.08	0.43	0.09
$\Delta s_{i,t}$	$\alpha2$	0.20	0.14	0.64	0.11	0.35	0.07	0.42	0.09	0.55	0.07
$\Delta s_{i,t-1}$	$\alpha3$	0.33	0.13	0.19	0.11	0.25	0.07	0.06	0.08	0.08	0.07
	$\alpha2+\alpha3$	0.53		0.83		0.61		0.48		0.63	
$\Delta uc_{i,t}$	$\alpha4$	0.07	0.20	−0.30	0.09	−0.13	0.04	−0.41	0.07	−0.38	0.05
$\Delta uc_{i,t-1}$	$\alpha5$	−0.52	0.22	−0.08	0.12	−0.10	0.06	−0.28	0.09	−0.28	0.08
	$\alpha4+\alpha5$	−0.45		−0.38		−0.23		−0.69		−0.66	
$k_{i,t-2}$	$\alpha6$	−0.35	0.07	−0.16	0.03	−0.19	0.02	−0.15	0.02	−0.28	0.02
$s_{i,t-2}$	$\alpha7$	0.35	0.08	0.10	0.03	0.14	0.03	0.14	0.02	0.22	0.02
$uc_{i,t-2}$	$\alpha8$	−0.05	0.12	−0.14	0.06	−0.15	0.04	−0.11	0.06	−0.34	0.04
Rsquare		0.34		0.24		0.28		0.19		−0.20	
	Long-run elasticities of capital with respect to										
Sales	$\alpha7/\alpha6$	1.00	0.11	0.64	0.15	0.74	0.06	0.94	0.11	0.78	0.04
User cost	$\alpha8/\alpha6$	−0.15	0.34	−0.88	0.34	−0.77	0.19	−0.76	0.38	−1.20	0.14

Source: Authors' calculation. Estimation of Eq. (3) in the text. The dependent variable is the investment capital ratio. All equations contain time dummies (not reported). The standard errors of the long-run elasticities are computed with the delta method. Instruments used for the OD estimation are lags $t-2$ of *ik*, *k*, *s* and uc and the time dummies.

Third, although the short-run effects of the user cost and of sales are always significant, their magnitude are, in contrast to the long-run effects, quite different across countries. Looking at the OD estimates, the sum of short-run coefficients on changes in the user cost range from −0.23 in Italy to −0.69 in Spain and the sum on the coefficients associated to the growth of sales range from 0.48 in Spain to 0.83 in France. One should, however, be careful about interpreting these differences across countries as structural differences. It is also noteworthy that although the qualitative results are very similar, the WITHIN estimates of the short-run coefficients suffer from a downward bias which is most severe in France and in Italy. This may indeed be due to the endogeneity problem.

4.2. The average interest rate on debt and monetary policy

In this section, we report the results of estimating Eq. (4) which links the average interest rate on debt to the short- and long-term interest rate. The base regressions (the first and third panel in Table 4) show that the average interest rate paid by firms responds positively and quite strongly to interest rate changes. The long-run pass-through of the short-term interest rate (π_3/π_2) is lowest in Germany and France (about 0.60) and highest in Italy (1.36) with Spain taking an intermediate position. This may in part be a result of the longer maturity structure of firms' debt in the former countries. Indeed, the third panel of Table 4 shows that the pass-through of the long-term interest rate is higher in Germany and France than in the other countries.

According to the theory of the financial accelerator (Bernanke et al., 1999), the interest paid by firms with weak balance sheets should react more to monetary policy shocks than the interest paid by firms with strong balance sheets. Since the strength of the balance sheet is endogenous, we use size dummy variables to test if the average interest paid by small firms responds more to interest rate changes (see the second and fourth panel of Table 4). Overall, we do not find compelling evidence that the interest rate cost of small firms reacts stronger than that of medium or large sized firms.

4.3. Size and the effect of the user cost on investment

The size of firms is often used as a criterion to distinguish between those firms that are liquidity constrained and those that are not. But only a perfect measure of the user cost of capital would capture the effects of such liquidity constraints by a higher user cost of capital. Because our measure is based on the average interest rate paid on debt rather than on the marginal interest rate and because there may be an unobserved shadow cost associated with small firms, it is worth analysing whether the sensitivity of investment with respect to the user cost depends on the size of the firms. After having shown that the interest rate component of the user cost is correlated to monetary policy, we test whether the effects of the user cost on investment depend on the size of the firm. If the financial accelerator matters for the transmission of monetary policy, changes in the level of interest rate should imply changes in the external financial premium. The user cost should have smaller effects on large

Table 4
Firm specific apparent interest rate and the short-term and long-term interest rates

Within estimates		Germany Coefficient	Germany Std. error	France Coefficient	France Std. error	Italy Coefficient	Italy Std. error	Spain Coefficient	Spain Std. error
		Firm specific and short-term interest rates							
Δi_t	$\pi 1$	0.31	0.03	0.34	0.02	0.60	0.03	0.25	0.02
$ID_{i,t-1}$	$\pi 2$	−0.55	0.08	−0.66	0.04	−0.51	0.05	−0.47	0.04
i_{t-1}	$\pi 3$	0.34	0.04	0.40	0.03	0.69	0.04	0.42	0.03
	$\pi 3/\pi 2$	0.61		0.60		1.36		0.89	
Rsquare		0.66		0.51		0.61		0.40	
	Including differentiated effects for firms of different size								
Δi_t* Small	$\pi 1$	0.27	0.04	0.28	0.03	0.66	0.04	0.17	0.03
Δi_t* Medium		0.33	0.05	0.36	0.04	0.60	0.04	0.27	0.03
Δi_t* Large		0.32	0.04	0.37	0.04	0.51	0.04	0.30	0.04
$ID_{i,t-1}$	$\pi 2$	−0.58	0.09	−0.66	0.04	−0.55	0.04	−0.47	0.04
i_t* Small	$\pi 3$	0.30	0.04	0.39	0.04	0.80	0.06	0.42	0.03
i_t* Medium		0.38	0.04	0.42	0.04	0.71	0.04	0.42	0.03
i_t* Large		0.36	0.05	0.38	0.04	0.62	0.05	0.42	0.03
Small	$\pi 3/\pi 2$	0.52		0.59		1.46		0.90	
Medium		0.65		0.64		1.30		0.89	
Large		0.63		0.58		1.14		0.88	
Rsquare		0.68		0.52		0.63		0.40	
		Firm specific and long-term interest rates							
Δl_t	$\pi 1$	0.30	0.02	0.28	0.04	0.38	0.02	0.25	0.03
$ID_{i,t-1}$	$\pi 2$	−0.53	0.03	−0.60	0.04	−0.54	0.04	−0.51	0.03
l_{t-1}	$\pi 3$	0.72	0.04	0.58	0.03	0.49	0.03	0.33	0.02
	$\pi 3/\pi 2$	1.38		0.98		0.90		0.64	
Rsquare		0.52		0.41		0.56		0.32	
	Including differentiated effects for firms of different size								
Δl_t* Small	$\pi 1$	0.25	0.03	0.22	0.03	0.42	0.03	0.19	0.04
Δl_t* Medium		0.36	0.03	0.32	0.06	0.39	0.04	0.23	0.04
Δl_t* Large		0.29	0.06	0.32	0.09	0.32	0.04	0.33	0.05
$ID_{i,t-1}$	$\pi 2$	−0.53	0.03	−0.60	0.04	−0.57	0.03	−0.52	0.04
l_t* Small	$\pi 3$	0.64	0.05	0.59	0.05	0.60	0.03	0.27	0.03
l_t* Medium		0.79	0.05	0.65	0.05	0.48	0.03	0.35	0.03
l_t* Large		0.74	0.09	0.52	0.04	0.44	0.04	0.38	0.04
Small	$\pi 3/\pi 2$	1.11		0.90		1.09		0.58	
Medium		1.37		0.99		0.89		0.74	
Large		1.28		0.79		0.80		0.80	
Rsquare		0.53		0.42		0.57		0.33	

Source: Authors' calculation. Estimation of Eq. (4) in the text. The dependent variable is the first difference of the firm-specific interest rate ($\Delta ID_{i,t}$). The independent variables are the first difference and the level of the three month money market and the government bonds interest rate, the level of the firm-specific interest rate ($ID_{i,t}$) and the product of the short-term or the long-term rate with size class dummies.

Table 5
Size and the effect of the user cost on investment

Within estimates		Germany		France		Italy		Spain	
		Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
$IK_{i,t-1}$	$\alpha1$	0.02	0.06	0.12	0.04	0.00	0.04	0.22	0.04
$\Delta s_{i,t}$	$\alpha2$	0.16	0.07	0.25	0.05	0.15	0.03	0.13	0.04
$\Delta s_{i,t-1}$	$\alpha3$	0.33	0.07	0.17	0.05	0.11	0.03	0.05	0.04
	$\alpha2 + \alpha3$	0.48		0.42		0.26		0.18	
$\Delta uc_{i,t}*$ Small		−0.28	0.16	−0.15	0.07	−0.07	0.04	−0.30	0.06
$\Delta uc_{i,t-1}*$ Small	$\alpha5$	−0.51	0.16	0.06	0.06	−0.01	0.04	−0.11	0.06
	$\alpha4 + \alpha5$	−0.80		−0.10		−0.09		−0.40	
$\Delta uc_{i,t}*$ Medium	$\alpha4$	−0.36	0.15	−0.02	0.06	−0.10	0.04	−0.28	0.06
$\Delta uc_{i,t-1}*$ Medium	$\alpha5$	−0.41	0.15	0.04	0.06	−0.03	0.04	−0.11	0.06
	$\alpha4 + \alpha5$	−0.77		0.01		−0.12		−0.39	
$\Delta uc_{i,t}*$ Large	$\alpha4$	−0.15	0.15	−0.07	0.06	−0.06	0.04	−0.26	0.06
$\Delta uc_{i,t-1}*$ Large	$\alpha5$	−0.23	0.14	0.10	0.06	0.00	0.04	−0.07	0.06
	$\alpha4 + \alpha5$	−0.37		0.03		−0.06		−0.33	
$k_{i,t-2}$	$\alpha6$	−0.14	0.03	−0.04	0.01	−0.06	0.01	−0.06	0.01
$s_{i,t-2}$	$\alpha7$	0.17	0.04	0.04	0.01	0.05	0.01	0.06	0.01
$uc_{i,t-2}$	$\alpha8$	−0.11	0.06	−0.03	0.03	−0.05	0.02	−0.05	
									0.04
Rsquare		0.51		0.48		0.43		0.37	

Test of the restriction that the short-run effects of the user cost are equal for all sizes

Germany F-stat	Germany P. val.	France F-stat	France P. val.	Italy F-stat	Italy P. val.	Spain F-stat	Spain P. val.
1.54	0.19	1.14	0.34	0.19	0.94	0.24	0.91

Source: Authors' calculation. Estimation of Eq. (3) extended to allow for different short-run effects of the user cost for firms of different size. The dependent variable is the investment capital ratio. The independent variables are the lagged investment capital ratio and appropriate lags of the growth rates and the logarithm of sales and the user cost of capital and of the capital level. The growth rate of the user cost is multiplied by dummy variables for each size class. The F-stats are computed on the basis of the residual sum of square of the unrestricted model above and the restricted model presented in Table 3.

firms for which the external finance premium should be less severe. We interact the short-run effects of the user costs with size dummies. [25]

Table 5 reports the results of the unrestricted model and the Fisher tests for the constraints of similar effects across firms of different sizes. We observe some differences across size classes. For instance, the short-run effects of the user costs on large German firms is half of what it is measured to be for small and medium firms. However, for every country, we cannot reject that the short-run effects of the user cost is

[25] We assume that the long-run elasticity (which is given by the production function parameters) is not affected by size.

the same across size classes. Overall, there appears to be no evidence that the investment of small firms is more sensitive to changes in the user cost than the investment of large firms.

5. Conclusion

In this paper we have analysed the effects of a change in the user cost of capital and of sales on firms' investment in Germany, France, Italy and Spain using a data set which provides aggregated balance sheet and profit and loss account data for 17 different industries and three different size classes. Our main findings are twofold. First, in each of the four countries a change in the user cost of capital has both statistically and economically significant effects on investment. The long-run effect of changes in the user cost on the capital stock does not reject a Cobb–Douglas production technology. We obtain a somewhat higher and more significant user cost elasticity than what is usually obtained with panels of individual firm-level data where mostly tax changes are used to identify changes in the user cost. In part, our stronger results could also be due to the fact that the data we use are actually for "representative firms" for which some of the measurement problems typical of panels are averaged out. Overall, the effects of the user cost on investment suggest that the interest rate channel of monetary policy is operative in the euro area. Changes in the level of interest rates have an impact on firms' investment through the user cost of capital.

Second, while the average interest paid by small firms is significantly larger than the average interest paid by large firms, there is no evidence that the premium paid by small firms reacts to changes in the interest rate. There is also no evidence that investment of small firms is more sensitive to the user cost of capital than investment of large firms. These findings put some doubt on the possibility that financial accelerator phenomena play an important role in the transmission mechanism of monetary policy for the large countries of the euro area during the sample period. However, a number of drawbacks of the data we used need to be kept in mind. First, the data does not allow to test for distributional effects of monetary policy among the firms within each size class. Second, our measure of the cost of debt is an average interest rate rather than the marginal cost of debt.

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Appendix A. Data sources, data construction and cleaning

A.1. Construction of the sample

The source of the data is the BACH-database from the European Commission. It contains aggregated balance sheet and profit and loss account information for 17 (13 for Germany) different industries (both manufacturing and services) and three size classes of firms. Small firms have a turnover of 7 million ECU or less, medium sized firms have a turnover between 7 and 40 million ECU. Large firms have a turnover of more than 40 million ECU. There are 51 "firm size-industry classes" (39 for Germany) for each country. The years of data available are for Germany (1988–1997), for France (1985–1998), for Italy (1983–1998) and for Spain (1983–1998).

Outliers of the variables are detected by the following robust regression technique. Outliers are looked for year by year for all variables used in the regressions. An observation is considered an outlier for a given year when it deviates from the median of that variable (the median of the given year) by more then 3.5 times the median absolute deviation. Outliers are then replaced by the median plus or minus 3.5 times the median absolute deviation.

A.2. Construction of the variables

- $\mathrm{IK}_{i,t}$: Investment ratio. The investment ratio is constructed by dividing the deflated book value of investment (at time t) by the deflated book value of capital (at time $t-1$). The book value of investment I_t is calculated by $K_t - K_{t-1} + \mathrm{Depreciation}_t$. The book value of capital is measured by fixed assets. The book value of the capital stock and investment are deflated by the industry investment price deflator (at the industry level).
- $\mathrm{UC}_{i,t}$: User cost of capital. Is constructed as explained in the main text.
- P_I: The industry investment price deflator from Eurostat.
- P: The industry output price deflator from Eurostat.
- $\Delta s_{i,t}$: Real sales growth. Real sales growth is measured as nominal sales growth minus goods price level inflation (as measured by the industry output price deflator).
- $\mathrm{ID}_{i,t}$: Average interest on financial debt. Interest is measured by interest payments on financial debts. Debt is measured by the book value of amounts owned to credit institutions plus other creditors plus debenture loans. Financial debt does not include trade credit. Real ID is nominal ID minus the inflation rate as measured by the GDP-deflator.
- $\mathrm{DA}_{i,t}$: Debt asset ratio. Debt is measured by summing all credit (both financial and trade). Assets are measured by total assets.
- $\mathrm{SD}_{i,t}$: Short-term debt as a fraction of total financial debt. Short-term debt is financial debt payable within one year.
- $\mathrm{BK}_{i,t}$: The ratio of land and buildings in total fixed assets. Used as a measure of collateralisable assets.
- l_t: the long-term interest rate. The interest rate on government bonds (BIS).

A.3. List of the industries used

The following industries are used.

- Extraction of metalliferous ores and preliminary processing of metal;
- Extraction of non-metalliferous ores and manufacture of non-metallic mineral products;
- Chemical and man-made fibers;
- Manufacture of metal articles, mechanical and instrument engineering;
- Electrical and electronic equipment including office and computing equipment;
- Manufacture of transport equipment;
- Food, drink and tobacco;
- Textiles, leather and clothing;
- Timber and paper manufacturing, printing;
- Other manufacturing industries not elsewhere specified;
- Building and civil engineering;
- Wholesale trade, recovery services;
- Sale of motor vehicles, wholesale and retail trade;
- Retail trade;
- Hotels–restaurants;
- Transportation and communication;
- Other services not included elsewhere.

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