BRUSSELS ECONOMIC REVIEW - CAHIERS ECONOMIQUES DE BRUXELLES
VOL. 45 - N°3 AUTUMN 2002

THE INTEREST RATE AND CREDIT CHANNELS IN BELGIUM: AN INVESTIGATION WITH MICRO-LEVEL FIRM DATA

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ABSTRACT

This paper investigates the effects of monetary policy on firms' investment behaviour through the interest rate and credit channels. The analysis relies on a comprehensive database of Belgian firms covering all sectors of economic activity and firms of all sizes. We proceed in two steps. First, we estimate a reduced-form investment equation derived from the neo-classical model, augmented by cash flow. This equation gives us the sensitivity of investment to the user cost, sales and cash flow. This allows us to assess the relative importance of the interest rate and credit channels. We simulate the effect of a transitory change in the market interest rate on investment through changes in the user cost of capital and the cash flow-capital ratio. We additionally compute the long-run elasticity of the capital stock to the market interest rate. We perform both exercises for various sample splits according to sectors and sizes. Our results indicate that in the manufacturing and construction sector, small firms are more sensitive to monetary policy than large firms, that firms in the construction sector are more sensitive than firms in other sectors and that services firms are almost unaffected. The interest rate channel appears to be the dominant channel of monetary transmission; it accounts for 75% of the first-year effect of an interest rate change.

JEL CLASSIFICATION: C23, D21, E50.

KEYWORDS: Investment, Monetary transmission, Credit channel, Panel data.

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We would like to thank members of the Eurosystem 's Monetary Transmission Network, participants of the ECB conference on the Monetary Transmission Network in December 2001, as well as participants of the EEA-ESEM conference in Venice, 2002, and SOEP conference on panel data in Berlin, 2002, for helpful comments and suggestions.

The views expressed in this paper reflect only the views of the authors. They do not necessarily reflect the views of the European Central Bank, or of the National Bank of Belgium.

1. Introduction

For the conduct of monetary policy it is essential to understand the transmission mechanism through which changes in the policy-controlled interest rate will affect the real economy and inflation. This mechanism is, however, rather complex since it operates through various channels and involves the behaviour of all sectors of the economy. In this paper we focus on monetary transmission and firms' investment in Belgium[1]. To our knowledge, this is the first paper to approach this topic using micro data. As we explain below, the use of micro data offers some considerable advantages compared to aggregate data.

In the literature one usually distinguishes two major channels through which business investment is influenced by monetary policy action: an interest rate channel and a credit channel. The interest rate channel conveys the direct impact of interest rate changes on the user cost of capital and subsequently on firms' investment. The credit channel derives from capital market imperfections. Asymmetric information, moral hazard and agency costs between lenders and the firm drive a wedge between the internal (cash flow, liquidity) and external (debt, equity) cost of financing. Hence, not all firms face the same market interest rate. The level of the external finance premium required by the lender depends, among other things, on the strength of the balance sheet[2] (several papers develop these ideas, starting with Jensen and Meckling, 1976, Stiglitz and Weiss, 1981, Myers and Majluf, 1984). Some firms, showing weak balance sheets, may even be credit-constrained and have to rely on internal resources. In such a world, monetary policy shocks may change the external finance premium required by lenders by altering the net worth of a firm and thus its ability to provide collateral. Monetary policy shocks may also affect the available amount of internal resources, such as cash flow, for instance by changing interest charges. Moreover, it is generally accepted that these mechanisms are amplified for firms with weak balance sheets.

The empirical identification of the interest rate and credit channel is a challenging and yet unresolved task. The interest rate channel may be associated with the effects that operate through the user cost. Indeed, a change in the market interest rate modifies the user cost of capital through the interest rates the firms face, and this influences in turn their investment behaviour. However, a change in the monetary policy stance also affects the firm-specific external finance premium embodied in the firm-specific interest rate, and this is part of the credit channel.

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[1] An earlier version of this paper is part of the Monetary Transmission Network project conducted by EU-12 central banks and co-ordinated by the European Central Bank, which results have been published as ECB Working Papers n°91 to n°114, and will be summarised in "Monetary Policy Transmission in the Euro Area", I. Angeloni, A. Kashyap and B. Mojon (eds), Cambridge University Press, 2003, forthcoming.

[2] The credit channel potentially operates through either a balance sheet channel or a bank lending channel (or through both). In the balance sheet channel the strength of the firms balance sheet is central in determining the external finance premium. In the bank lending channel the supply of loans is dependent on the strength of bank balance sheets. Both channels however imply an increasing external finance premium for firms with weak balance sheets in the presence of adverse monetary policy shocks (Bernanke and Gertler, 1995).

Therefore, we will attribute to the interest rate channel only the changes to the interest rate that are common to all firms.

Since the credit channel is related to the existence of financial constraints, it may be captured by the impact on investment through cash flow. Thereby, one follows Fazzari et al (1988) who interpret differences in the cash flow sensitivity of investment as an indication of differences in the degree of financial constraints (i.e. external finance premia). This interpretation should, however, be treated with caution, as Kaplan and Zingales (1997) have shown that it only holds if the cash flow sensitivity is a monotonic function of the degree of financial constraints. Furthermore, cash flow may also be correlated with firm profitability, and since current profits can be interpreted as a proxy for profit expectations, cash flow may capture profit expectations rather than credit constraints[3]. In this paper, with the caution discussed above, we assess the credit channel with the monetary policy effects triggered through cash flow. We thus ignore the effects that may operate through the external finance premium embedded in the user cost of capital[4].

The previous discussion has put forward some elements that motivate the strategy we choose to study the effects of monetary policy changes on firms' investment. We rely on a large panel of Belgian firms. The use of micro data is essential since it allows us to analyse firms in different financial positions, and thus to assess the relevance of the credit channel. This is impossible with aggregate data. One should also mention that, compared to other panel data studies, including those on the Belgian economy (see Barran and Peeters, 1998, Deloof, 1998, Vermeulen, 1998), which generally focus on a very limited sample of large and/or manufacturing firms, we include in our study firms of all sectors and sizes, as do more recent papers on Belgium (Cincera, 2002, Gérard and Verschueren, 2002). Thanks to the size and scope of our data set we can take into account heterogeneity in firms' investment behaviour along multiple dimensions and estimate a specific investment equation for each sector and size separately. The use of micro data offers another advantage. Aggregate studies have often failed to find a significant relation between the user cost of capital and investment due to simultaneity biases. Constructing firm-specific measures for the user cost overcomes this problem.

We follow a two-step estimation procedure. In the first step, we estimate a reduced-form investment equation[5], which is derived from the traditional neo-classical model

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[3] See also Fazzari et al (2000) and Kaplan and Zingales (2000) over this controversy, and the survey of Chatelain (2002) over the difficulties encountered in the interpretation of investment-cash flow sensitivity as an indicator of financial constraints.

[4] We also neglect potential changes in the investment-cash flow sensitivity.

[5] In the light of the Lucas critique (1976), another strand of empirical research on investment adopts a more structural approach and tries to derive a tightly parameterised model from the firm's intertemporal optimisation problem under explicit assumptions. This type of work directly estimates Euler equations for the capital stock (see, for instance, Bond and Meghir, 1994, Chatelain and Teurlai, 2000, Whited, 1992, and, for Belgium, Barran and Peeters, 1998, Gérard and Verschueren, 2002). Although from a theoretical point of view this approach is more appropriate (since it delivers policy-invariant parameter estimates), it has often failed to produce significant and correctly signed adjustment cost parameters. Chatelain and Teurlai (2000) argue that the assumption of a symmetric quadratic

of investment (Jorgenson, 1963). We augment this standard model with lagged variables that take care of adjustment costs and expectations, and with cash flow to capture financial constraints. While neoclassical theory highlights the role played by fluctuations in the user cost in determining the level of investment, most empirical papers omit this variable, and introduce time dummies and fixed effects, instead (Bond et al.,1997, or Mairesse et al.,1999). These variables, however, not only proxy for the user cost but for all omitted aggregated time-variant or firm-specific time-invariant influences. For the scope of our analysis of monetary policy transmission, we explicitly include a measure of the user cost of capital. Estimated by the Arrelano and Bond (1991) first difference GMM procedure, our investment equation gives us the sensitivity of investment to the user cost and cash flow. This allows us to investigate whether the interest rate and/or credit channels are relevant or not. In a second step, we evaluate the relative importance of both channels. For that purpose, we simulate the effect of a transitory change in the three-months market interest rate on the user cost of capital and the cash flow-capital ratio, and thereby on investment. We additionally compute the long-run elasticity of the capital stock to the market interest rate, with respect to the interest rate channel.

Our results may be briefly summarised as follows. We find evidence that small firms are more sensitive to monetary policy than large firms, that construction firms are more sensitive than firms in other sectors. The interest rate channel appears to be the dominant channel of monetary transmission. It accounts for 75% of the first-year effect of an interest rate change. As investment of service firms is insensitive to the user cost of capital, the interest rate channel is inoperative in this sector. On the contrary, the credit channel has large effects in the short and medium run, especially for small service firms.

The paper is organised as follows. Section 2 derives the reduced-form investment equation from the neo-classical model. Section 3 describes our dataset and some features of corporate finance in Belgium. The empirical part is split into two. Section 4 presents the estimates of the investment equation by sector and size. Section 5 simulates the short-run impact of a 100 basis points interest rate increase on the investment-capital ratio through the firm-specific user cost of capital and through the cash flow-capital ratio. It also computes the long-run elasticity of the stock of capital with respect to the market interest rate that is due to the interest rate channel. Finally, in section 6, we formulate our conclusions.

2. Theoretical Framework for the Reduced-Form Investment Equation

In order to evaluate the interest rate and credit channels we proceed in two steps. In the first step we estimate an investment equation derived from a neo-classical model. In the second step we focus on the impact of monetary policy on the user cost of capital and on the cash flow-capital ratio.

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[5] adjustment cost function may be too restrictive. Moreover, although the Euler equation itself is structural, the variables that explain the financial constraints are entered ad hoc after the firm's optimisation is solved (see the criticism of Vermeulen, 1998).

It can be shown, as in Mairesse et al. (1999), that the neo-classical model of the profit-maximising firm (as pioneered by Jorgenson, 1963) leads to the following capital demand equation, when we assume a generalised CES production function (as in Eisner and Nadiri, 1968), and no irreversibility, uncertainty, delivery lags, costs of adaptation or taxes:

$$\log(K_{it}) = \theta.\log(Y_{it}) - \sigma.\log(UCC_{it}) + \log(H_{it}) \qquad (1)$$

where UCC_{it} is the real user cost of capital of firm i in year t,

Y_{it} represents real output ,
$H_{it}=[TFP_i.A_t]^{(\sigma-1)/\upsilon}(\upsilon\alpha_i)^{\sigma}$, where $TFP_i.A_t$ stands for total factor productivity,
υ is the elasticity of scale,
σ is the elasticity of substitution between capital and labour,
α_i is the capital share of firm i,
$\theta=\left(\sigma+\frac{1-\sigma}{\upsilon}\right)$.

Equation (1) represents the equilibrium value of the real capital stock. As can be shown from the expression for θ, the long-run elasticity of capital to output is unity when $\sigma=1$ (Cobb-Douglas) or when $\upsilon=1$ (constant returns to scale).

Assuming a partial adjustment process of order p, we obtain the following autoregressive distributed lag (ADL) capital demand equation[6]:

$$\begin{aligned}\log(K_{it}) = {} & \varpi_1.\log(K_{it-1}) + \varpi 2.\log(K_{it-2}) + \ldots + \varpi p.\log(K_{it-p}) \qquad (2)\\ & - \sigma_0.\log(UCC_{it}) - \sigma_1.\log(UCC_{it-1}) - \sigma_2.\log(UCC_{it-2}) - \ldots. - \sigma_p.\log(UCC_{it-p})\\ & + \theta_0.\log(Y_{it}) + \theta_1.\log(Y_{it-1}) + \theta_2.\log(Y_{it-2}) + \ldots. + \theta_p.\log(Y_{it-p})\\ & + \phi_0.\log(H_{it}) + \phi_1.\log(H_{it-1}) + \phi_2.\log(H_{it-2}) + \ldots. + \phi_p.\log(H_{it-p})\end{aligned}$$

Next, as in the usual accelerator model, we take first differences and approximate the net growth in the capital stock $\Delta\log(K_{it})$ by $I_{it}/K_{it-1}-\delta_i$ where δ_i is the firm-specific depreciation rate. Time dummies are sufficient to capture the terms in $\Delta\log(H_{it})$ since the firm-specific effects, TFP_i and α_i, drop out by first differencing. This leaves us with the equation:

$$\begin{aligned}(I_{it}/K_{it-1}) = {} & (1-\varpi_1-\varpi_2-\ldots\varpi_p).\delta_i + \varpi_1.(I_{it-1}/K_{it-2}) + \varpi_2.(I_{it-2}/K_{it-3}) + \ldots + \varpi_p.(I_{it-p}/K_{it-p-1}) \qquad (3)\\ & - \sigma_0.\Delta\log(UCC_{it}) - \sigma_1.\Delta\log(UCC_{it-1}) - \sigma_2.\Delta\log(UCC_{it-2}) - \ldots. - \sigma_p.\Delta\log(UCC_{it-p})\\ & + \theta_0.\Delta\log(Y_{it}) + \theta_1.\Delta\log(Y_{it-1}) + \theta_2.\Delta\log(Y_{it-2}) + \ldots. + \theta_p.\Delta\log(Y_{it-p})\\ & + \text{time dummies} + \varepsilon_{it}\end{aligned}$$

[6] Rearranging this equation, as in Mairesse et al. (1999), we obtain an error correction model (ECM), which expresses the growth rate of the capital stock as a function of both growth rate and level variables. Theoretically, this equation has more appeal, because it distinguishes between long- and short-term effects. However, empirically capturing the long-term over a limited period of time is a perilous undertaking. Note that if there is a firm-specific productivity growth rate, the ECM is invalid; it must be differenced. This is not the case for the ADL specification (3).

Finally, this equation is augmented with a distributed lag of the cash flow-capital ratio, denoted by $cash_{it}/K_{it-1}$, in order to capture financing constraints. In most studies, output is proxied by sales. However, since small firms do not have to report sales in Belgium, we use instead value added (VA_{it}) for all firms. If we make the assumption that value added is proportional to sales, the coefficient for output in equation (1) keeps the same structural interpretation for value added. So, we finally obtain the following estimable equation:

$$\begin{aligned}(I_{it}/K_{it-1}) = {} & (1-\varpi_1-\varpi_2-...\varpi_p).\delta_i + \varpi_1.(I_{it-1}/K_{it-2}) + \varpi_2.(I_{it-2}/K_{it-3}) + ... + \varpi_p.(I_{it-p}/K_{it-p-1}) \\ & + \theta_0.\Delta\log(VA_{it}) + \theta_1.\Delta\log(VA_{it-1}) + \theta_2.\Delta\log(VA_{it-2}) + ... + \theta_p.\Delta\log(VA_{it-p}) \\ & - \sigma_0.\Delta\log(UCC_{it}) - \sigma_1.\Delta\log(UCC_{it-1}) - \sigma_2.\Delta\log(UCC_{it-2}) - .... - \sigma_p.\Delta\log(UCC_{it-p}) \\ & + \beta_0.(cash_{it}/K_{it-1}) + \beta_1.(cash_{it-1}/K_{it-2}) + ...+ \beta_p.(cash_{it-p}/K_{it-p-1}) \\ & + \text{time dummies} + \varepsilon_{it}\end{aligned} \quad (4)$$

Equation (3) deviates from Mairesse et al. (1999) because we do not replace the user cost by time dummies and fixed effects. Indeed, we are interested in the transmission channels of monetary policy, for which the user cost of capital is a central variable.

We still need a fixed effect to deal with the firm-specific depreciation rate[7]. Moreover, the presence of the lagged dependent variable and the likely endogeneity of output, user cost and cash flow require an instrumental variable approach in order to obtain consistent estimates. We use the Arrelano and Bond (1991) GMM first differences estimator. Hereby, we consider the largest set of instruments available, i.e. second lag and beyond of the investment-capital ratio, of the first difference of the user cost, the first difference of the value added and cash flow-capital ratio. For the sake of brevity, in section 4, we present only the results of the second-step estimates[8] which are robust to residual heteroskedasticity. Since equation (4) is estimated in first differences in order to eliminate the fixed effects and since we consider four lags, we need at least seven years of observations per firm[9]. The estimation therefore runs over the period 1991-1998, and the earliest instrument is dated 1986.

3. Description of Belgian Data

3.1. Description of our data set [10]

Our analysis relies on Belgian annual accounts data, which are collected by the National Bank of Belgium. Since the reporting of annual accounts is a legal requirement for (nearly)

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[7] Even assuming a non-specific depreciation rate, the investment equation might still require a fixed effect if productivity growth instead of the level of productivity is firm-specific.

[8] Although the second step t-statistics may be upwards biased, the consistency of the point estimates improves, provided that the sample is large, which is the case in our study. Our estimates may, however, suffer from a weak instrument problem due to the non stationarity of the investment rate. An alternative estimation strategy in this case is the Arrelano and Bover (1995) system GMM estimator. Checking the consistency of our results with respect to this estimation procedure is left for future research..

[9] Wald tests, reported in the tables, show that, in most of the cases, lag four is significant. Further, preliminary estimates show that an ADL(3) model is misspecified for small firms (in the sense that the Sargan statistic rejects the model).

[10] A more detailed description of the data is to be found in Appendix A.

every firm in Belgium for several decades now, our database is extremely representative, covering (almost) completely the population of Belgian non-financial firms. In this respect, our database differs from databases in other countries, which are often collected on a voluntary basis and/or intended to serve a very particular purpose. In 1998, 228,566 firms met their legal obligation. On average about 10% of the Belgian firms, however, fail to comply with this requirement, so that no information is available for those firms. All accounts are subjected to a long list of accounting and logical consistency controls before they enter the database. If necessary, corrections are made. The data therefore satisfy the highest quality standards. The annual accounts of small firms, which represent the vast majority in the database (around 92.5% of all firms), are submitted in a different format from that of large[11] firms and essentially contain less information.

Our sample draws on a period of 15 years (1985-1998) of annual accounts. We use an unbalanced panel, since we want to avoid major survivor biases. But, at the same time, we select only firms, for which consistent data are available for at least seven consecutive years, in order to allow for some rich dynamics in our investment equation. We furthermore remove outliers by excluding firm-years for which at least one of the variables of interest (except value added, which is scale-dependent) belongs to the first or 99th percentile. This trimming procedure is repeated year by year and for large and small firms separately. We are left with a final unbalanced sample of 29,600 firms representing 157,547 firm-year observations. This is around 12% of the database, which originally amounted to more than one and a half million observations[12]. Although this seems a small number, most of the observations lost are from very small (service) firms. At the sector level, manufacturing industries and construction are slightly overrepresented in our final sample, but this should not be harmful to our results as we analyse each sector separately. Although there is a small bias towards large firms in our final sample[13] the number of very small firms is still quite large. Around 10% of the firms have only one employee, and 44% of the firms employ at most five persons. All in all, compared to other data sets used in the literature, our sample is still very representative of the Belgian private sector. Appendix A discuss the representativeness of our sample in more details.

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[11] According to Belgian accounting legislation, a company is regarded as "large", in 1999, either when the yearly average of its workforce is at least 100 or when at least two of the following thresholds were exceeded: (1) yearly average of workforce: 50, (2) turnover (excluding VAT): EUR 6,250,000, (3) balance sheet total: EUR 3,125,000. In general, the values of the latter two thresholds are altered every four years in order to take account of inflation. In terms of aggregate economic activity, large firms account for a large proportion of the private sector.

[12] 97% of the observations of the initial sample refers to firms that may be considered as "profit-maximising". 90% of the annual accounts are satisfactory in the sense that total assets, total liabilities, real fixed assets and depreciation rate are strictly positive. "Unsatisfactory" accounts often belong to firms which are in a particular situation, such as bankruptcy. After requiring that data is available for the level and first difference of all RHS and LHS variables, there remains only 52% of the sample. Almost 10% is again lost due to trimming for outliers. Finally, we loose 30% more by requiring a sample with enough consecutive annual accounts to estimate an ADL(4). The major loss of observations arises because we restrict the sample to firms with at least seven consecutive observations. We therefore exclude very recent firms, short-lived firms, firms which have been absorbed through merging, firms which have change their name, etc.

[13] The share in total value added for the manufacturing sector is 18.9% according to the national accounts, whereas it is 43.8% in our sample. For construction the values of these shares are respectively 4.8% and 7.7% respectively, and for services the share in value added reported in annual accounts is 52.2% against 42.2% in our final sample.

3.2. The financial structure of Belgian firms

Corporate finance has evolved substantially in the last decade in Belgium, but in a different manner according to firm's size or sector. For our purpose, we distinguish between small and large firms (in the accounting legislation sense), and between manufacturing, construction and service sectors[14]. Table 1 reports the relative share of the main liability items for these sub-samples. It shows that debt securities, i.e. corporate bonds or commercial paper, continue to play a minor role in the corporate financing decisions of Belgian companies, although their share is slightly rising. Firms also rely less on trade debt than in the past; this evolution points to a more efficient use of working capital from suppliers of goods vis-à-vis their customers. Small firms have almost completely compensated the cutback in this type of cheap financing by increasing their use of bank debt, especially long-term debt. Large firms, on the contrary, have even reduced their share of long-term bank debt considerably over the entire period. This reduction is particularly pronounced in the service sector. At the same time, non-bank financing ("other financial debt") exploded in the manufacturing and construction sectors, while equity financing increased by about a quarter for large service firms. This evolution can, to some extent, be explained by the development of the so-called co-ordination centres.

Since 1982, a distinctive feature of the Belgian corporate legislation has become the facility for large multinationals to set up a co-ordination centre. Co-ordination centres offer support and financial services to their affiliated firms on a low tax basis[15]. In their role of banker of the group, they have become the main source of external finance for their members. The rise in equity financing in the service sector partly reflects the capitalisation of the co-ordination centres by multinationals. The increase in non-bank financing is due to a shift from bank credit to intra-group loans, i.e. from the co-ordination centres to their affiliated firms.

Another important feature of the Belgian corporate sector is the presence of large shareholders, which often assume the structure of holding companies. They control many firms through pyramidal and complex ownership structures, and play a significant role not only in the financing but also in the management of their subsidiaries. Since in Belgium, as in the majority of other euro area countries, firms' direct access to capital markets has always been limited[16], holding companies, like co-ordination centres, may substitute for less developed corporate capital markets and provide external funds to the firms they control at lower costs thanks to reduced agency costs (less asymmetric information) and fiscal advantages. By doing so, they can alleviate possibly financial constraints for their affiliated firms[17].

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[14] Manufacturing covers the NACE classes 15 to 37 (we excluded electricity, gas and water), construction is NACE 45 and services includes NACE 50 to 52, 55, 60 to 67, 70 to 74, 85, 90 to 93 and 95.

[15] See also Barran and Peeters (1998), Deloof (1998) and Tychon (1997).

[16] In 2001, the stock market capitalisation of Belgian firms represented 72.6% of GDP (71.7% for the whole euro area), as compared to 137.1% in the US (Agresti and Claessens, 2002).

[17] Barran and Peeters (1988) provide empirical evidence that firms affiliated to a co-ordination centre are less financially constrained than other firms. Cincera (2002) reaches the same conclusion for Belgian subsidiaries of multinatioals. Unfortunately, information on group membership is only available for large firms. Since, in this paper, we analyse, among others, differences between small and large firms, we do not specifically consider the issue of group membership.

It is generally argued that the percentage of small firms that belong either to a multinational or to a holding company is rather restricted[18]. Hence, these types of fundings appear less relevant for small firms, and they have to resort to bank financing, for which they pay a higher fee. As shown in Table 2, the difference between the firm-specific interest rate of small and large firms lies between 2.6 and 4.4 percentage points on average. In the literature, several additional reasons are put forward to explain such a higher premium: both the risk and external finance premium of small firms are expected to be higher since they are engaged in more risky activities, are younger, are more difficult to screen, or have weaker balance sheet, and less collateralisable assets. Indeed, balance sheet indicators, such as liquidity and the inverse of the coverage ratio, reported in the last panel of Table 2 suggest that large firms may be in a better financial position than small firms[19], except in the construction sector. In particular, small service firms have much weaker liquidity and coverage ratios than large service firms. whereas the difference between small and large manufacturing firms is very thin.

TABLE 1 : FINANCIAL STRUCTURE OF BELGIAN FIRMS

small firms	**manufacturing**		**construction**		**services**	
% of total liabilities	1987-92	1993-98	1987-92	1993-98	1987-92	1993-98
loans of credit institutions	19.1	21.1	14.8	17.8	21.8	25.2
- maturity < 1 year	5.6	5.8	5.1	5.7	6.1	5.8
- maturity > 1 year	13.5	15.3	9.8	12.2	15.8	19.5
other financial debt (including debt securities)	2.6	3.5	1.8	2.6	3.7	4.8
trade debt	22.8	20.8	26.6	24.2	19.8	15.4
equity and reserves	34.6	33.0	35.8	33.9	34.2	32.8
large firms	**manufacturing**		**construction**		**services**	
% of total liabilities	1987-92	1993-98	1987-92	1993-98	1987-92	1993-98
loans of credit institutions	12.9	10.7	7.6	7.5	22.1	16.7
- maturity < 1 year	5.5	4.5	3.3	3.3	9.7	8.1
- maturity > 1 year	7.5	6.1	4.2	4.2	12.4	8.6
other financial debt (including debt securities)	11.4	17.0	1.3	2.6	11.2	13.2
trade debt	16.8	14.8	24.3	22.6	14.3	11.1
equity and reserves	35.6	36.1	20.9	20.3	35.5	42.9

source: annual accounts; firms' averages weighted by total assets

[18] In our sample, one of the reason might be the large number of very small firms (less than 5 or 10 employees).

[19] These indicators are constructed in such a way that a larger value of the ratio reflects a weaker balance sheet.

Table 2 also summarises some additional features of the different sub-samples in terms of capital intensity, size, investment ratio and cash flow. The size of firms in each sector varies substantially. On average, manufacturing firms are larger than in other sectors, both in terms of total assets as in terms of employment, and there are more very small firms (up to 5 employees) in the service sector than in other sectors. If the usual prior that small firms are more susceptible to face financial constraints is true it should certainly apply to small service firms. Further, small firms have a higher investment rate than large firms (around 0.19 to 0.20 as compared to 0.16-0.17 for large firms). In addition to weaker balance sheet indicators, they also have a lower cash flow rate (0.22 to 0.25 as compared to 0.27 to 0.39 for large firms). This suggests that they attribute a larger part of their internal funds to the financing of investment projects. All in all, Table 2 suggests that due to a worse financial position and higher information costs (due to the size of the firms), small firms may be more financially constrained, especially small service firms. The difference between small and large manufacturing firms may be less pronounced.

TABLE 2 : SUMMARY STATISTICS BY SECTOR AND SIZE

	Manufacturing		Construction		Services	
	small	large	small	large	small	large
capital intensity	51	99	31	33	85	169
Size						
total assets	869	41 043	543	15 536	661	18 769
employment	10.28	178.19	7.71	91.38	5.22	78.88
% of firms with at most 5 employee	24		40		50	
investment and finance						
investment-capital ratio	0.19	0.16	0.20	0.17	0.19	0.17
cash flow-capital ratio	0.22	0.27	0.25	0.29	0.23	0.39
firm-specific interest rate	13.85	9.44	11.92	8.73	11.43	8.75
balance sheet indicators						
Liquidity	1.57	1.38	1.16	1.33	5.41	1.76
coverage (inverse)	0.32	0.29	0.30	0.52	0.37	0.11

source: own calculations. Numbers are sample averages.
Capital intensity is the capital-labour ratio, calculated as the real capital stock in millions of 1995 euros over the number of employees; The firm-specific interest rate is constructed as interest charges net of capital and interest subsidies over total debt. Liquidity is the ratio of short-term debt over short-term liabilities. Coverage (inverse) is the ratio of interest rate charges on cash flow.

Finally, small firms are on average less capital-intensive than large ones. Service firms are more capital-intensive than other sectors; this is due to services such as real estate and transport-communication, which require huge investments. The construction sector is much less capital intensive than other sectors. Capital intensity may be related to the user cost elasticity of investment, which, according to the neoclassical model derived in Section 2, corresponds to the elasticity of substitution between capital and labour. We might then expect differences in the investment-user cost of capital sensitivity across sectors. Under competitive markets, the elasticity of substitution measures the proportional change in capital intensity of production following a proportional change in factor prices, i.e. $\sigma = d(\log(K/L))/d(\log(w/ucc))$.

4. Investment behaviour of Belgian firms

In this section we implement the first step of our analysis, i.e. we estimate equation (4) and investigate the relevance of the credit and interest rate channel. The extremely broad scope of our sample permits us to analyse the investment behaviour of different subgroups separately. This is essential for the purpose of our paper. In order to assess the validity of the credit channel of monetary transmission, one needs to compare the behaviour of firms in different financial positions. Moreover, it is well known that overall pooling introduces a bias in the subject-specific coefficients when individual behaviour is not homogenous. In Butzen et al (2001) we show that, while pooled estimates produce insignificant coefficients for the user cost parameter, disaggregated estimations point to significant user cost effects.

As already noted, we perform our sample splits according to size and sector. Size has commonly being used in the literature as a criterion to separate firms that are likely to face different degrees of financial constraints (for European evidence, see, for instance, Guiso, 1997, and Gaiotti and Generale, 2001, for Italy, Mörttinen, 2000, for inventories in Finland, von Kalckreuth, 2001, for Germany, Vermeulen, 2002, for Germany, France, Italy and Spain, Wesche, 2000, for Austria). Also, the stylised facts of the previous section suggest that small firms are charged a higher premium, and have a worse financial situation than large firms. Therefore, following Fazzari et al. (1998) we interpret differences in investment-cash flow sensitivity as an indication of differences in the degree of financial constraints, and we expect small firms to show a greater cash flow sensitivity than large firms. Another reason to use size as a criterion to split the sample is related to the dynamics of investment. Doms and Dunne (1998) provide evidence that investment at the plant level is lumpy. Therefore, since large firms usually consists of more plants than small firms, aggregation over several plants to obtain firm-level data should lead to a smoother investment pattern for large firms.

Sector differences may also induce different investment behaviour. Due to differences in the nature of their activities or in their production technology, one may expect sectors to face different degrees of financial constraints, and/or to have different sensitivities to the cost of capital. The previous section shows that construction firms are less capital intensive, while service firms are more capital intensive. The financial situation of small service firms is very much worse from that of large service firms, while there may be less differences in the manufacturing sector. So, sector is the second feature that seems relevant for a sample split.

We estimate investment equation (4) by the Arrelano-Bond first difference GMM procedure. The results of the second-step estimation are presented in Tables 3 and 4. We first focus on the dynamics of the investment rate. These are to a large extent driven by the coefficients of the lagged investment rates. The coefficient on the first lag is positive for large firms, whereas it is negative for small firms. A negative coefficient indicates that bursts of investment do not spill over to the next years, but are followed by lower investment rates two years later. This result is consistent with those on plant level data by Doms and Dunne (1998) who also point towards periodic bursts of investment. Moreover, given that 44% of the firms in our sample are very small (having at most five employees), they are likely to operate only one plant. This pattern makes investment a less smooth process. On the contrary, since investment of large firms results from the aggregation over several projects and plants, it is smoother.

Further, there is evidence of accelerator effects, especially in the manufacturing sector, where the long-run elasticity of capital to sales lies between 0.26 to 0.31. Large construction firms also respond with some delay to demand changes, but the negative influence of value added growth at lags 3 and 4 for large construction firms is rather distinctive. This presumably reflects some kind of cyclical behaviour. The coefficients on value added growth are insignificant for small service firms.

The long-run coefficient on changes in the user cost of capital is significantly negative, except in the service sector [20]. As explained in the preceding section, we expect the user cost elasticity of investment to differ across sectors. Our results suggest that the investment-user cost sensitivity is inversely related to the degree of capital intensity. Construction, which is the least capital intensive sector, shows the largest (in absolute value) user cost elasticity of all sectors. Services, the most capital intensive sector (see Table 2), has no significant user cost coefficient. And small manufacturing firms, which are less capital intensive than large manufacturing firms, react more to user cost changes than their larger counterparts. Disaggregating the results further at the branch level, Butzen et al (2001) confirm that the capital-user cost elasticity is inversely related to capital intensity, and, in general, not significant in the service sector.

Finally, there are also substantial differences in investment-cash flow sensitivity across sectors and size groups. As already noted, this coefficient is usually interpreted as reflecting the degree of financial constraints, although this interpretation should be considered with caution. However, our results support the financial constraints interpretation. Tables 3 and 4 show that, except in the manufacturing sector, small firms have a higher investment-cash flow sensitivity than large firms. The difference in long-run cash-flow sensitivity is very pronounced in the service sector: large service firms have the lowest value overall, 0.084, while small service firms have the highest, 0.365. This finding is consistent with the evidence provided in Table 2, which indicates that small service firms have the worst liquidity and coverage ratios, whereas large service firms have the best coverage ratio. The same reasoning applies to thin difference in cash-flow sensitivity between small and large manufacturing firms. It fits the similar balance sheet indicators of both sub-samples presented in Table 2.

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[20] Although the individual coefficients on user cost are not significant for large manufacturing firms, the total effect is. This may be due to correlations between the coefficients.

TABLE 3: ADL(4) MODEL OF INVESTMENT BY SECTOR FOR LARGE FIRMS

	Manufacturing		Construction		Services	
	coef	t-stat	coef	t-stat	coef	t-stat
I_{it-1}/K_{it-2}	0.039***	2.899	0.049***	3.235	0.066***	4.703
I_{it-2}/K_{it-3}	-0.035***	-3.291	-0.010	-0.766	-0.027***	-3.019
I_{it-3}/K_{it-4}	0.011	1.073	-0.026**	-2.240	-0.017**	-2.053
I_{it-4}/K_{it-5}	-0.001	-0.096	-0.012	-1.196	-0.011	-1.515
$\Sigma(I_{it-j}/K_{it-j-1})$	*0.015*	*0.455*	*0.000*	*-0.011*	*0.010*	*0.338*
$\Delta\log(VA_{it})$	0.143***	3.825	0.008	0.329	0.072*	1.755
$\Delta\log(VA_{it-1})$	0.076***	4.601	0.053***	2.576	0.049***	3.109
$\Delta\log(VA_{it-2})$	0.073***	5.116	0.023	1.281	0.035***	2.759
$\Delta\log(VA_{it-3})$	0.016	1.355	-0.045***	-2.988	0.021*	1.771
$\Delta\log(VA_{it-4})$	0.000	0.021	-0.030**	-2.286	0.006	0.625
$\Sigma\Delta\log(VA_{it-j})$	*0.309****	*4.403*	*0.008*	*0.118*	*0.183***	*2.543*
$\Delta\log(UCC_{it})$	-0.011	-1.377	-0.034**	-2.034	0.016	1.144
$\Delta\log(UCC_{it-1})$	-0.006	-1.001	-0.027**	-2.566	0.001	0.192
$\Delta\log(UCC_{it-2})$	-0.008	-1.216	-0.029***	-3.790	0.001	0.128
$\Delta\log(UCC_{it-3})$	-0.006	-1.249	-0.007	-0.949	0.000	0.020
$\Delta\log(UCC_{it-4})$	-0.001	-0.247	0.004	0.831	-0.005	-1.421
$\Sigma\Delta\log(UCC_{it-j})$	*-0.032****	*-3.181*	*-0.093****	*-2.800*	*0.013*	*0.567*
$cash_{it}/K_{it-1}$	0.037**	2.044	0.114***	3.724	0.054***	2.743
$cash_{it-1}/K_{it-2}$	0.098***	6.357	0.007	0.599	0.009	0.872
$cash_{it-2}/K_{it-3}$	0.011	0.914	0.016**	2.307	-0.005	-0.880
$cash_{it-3}/K_{it-4}$	0.040***	3.437	-0.006	-0.877	0.026***	4.245
$cash_{it-4}/K_{it-5}$	0.021**	2.093	0.003	0.415	0.000	0.018
$\Sigma\, cash_{it-j}/K_{it-j-1}$	*0.207****	*4.524*	*0.134****	*6.676*	*0.083****	*4.815*
	statistic	p-value	statistic	p-value	statistic	p-value
Sargan	119.501	0.622	118.816	0.639	118.957	0.635
Wald - lag 4	4.705	0.319	13.136	0.011	4.006	0.405
m1	-11.716	0.000	-8.011	0.000	-17.400	0.000
m2	0.363	0.717	-1.221	0.222	-0.717	0.474
# obs # firms	8158	1529	2720	452	16624	2826

2nd step GMM Arrelano-Bond estimates of the investment equation (4) over 1991-1998
the constant and time dummies are not shown
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

TABLE 4: ADL(4) MODEL OF INVESTMENT BY SECTOR FOR SMALL FIRMS

	Manufacturing		Construction		Services	
	coef	t-stat	coef	t-stat	coef	t-stat
I_{it-1}/K_{it-2}	-0.029*	-1.910	-0.034**	-2.320	0.018	1.456
I_{it-2}/K_{it-3}	-0.035***	-3.210	-0.041***	-4.177	-0.019***	-3.148
I_{it-3}/K_{it-4}	-0.021**	-2.194	-0.047***	-5.365	-0.015***	-2.846
I_{it-4}/K_{it-5}	-0.028***	-3.205	-0.036***	-4.713	-0.007	-1.388
$\Sigma(I_{it-j}/K_{it-j-1})$	*-0.113****	*-2.736*	*-0.158****	*-4.755*	*-0.023*	*-1.157*
$\Delta log(VA_{it})$	0.095	1.623	0.029	0.504	-0.017	-0.364
$\Delta log(VA_{it-1})$	0.083***	3.481	0.067***	3.269	0.008	0.464
$\Delta log(VA_{it-2})$	0.041*	1.919	0.054***	3.339	0.006	0.549
$\Delta log(VA_{it-3})$	0.038**	1.962	0.034**	2.452	-0.014	-1.355
$\Delta log(VAi_{t-4})$	0.032*	1.921	0.025**	2.242	0.005	0.761
$\Sigma\Delta log(VA_{it-j})$	*0.289****	*2.656*	*0.208***	*2.079*	*-0.012*	*-0.148*
$\Delta log(UCC_{it})$	-0.032	-1.643	-0.075**	-1.966	0.010	0.715
$\Delta log(UCC_{it-1})$	-0.023*	-1.851	-0.023	-1.210	0.005	0.753
$\Delta log(UCC_{it-2})$	-0.021*	-1.888	-0.002	-0.126	0.005	0.920
$\Delta log(UCC_{it-3})$	-0.016*	-1.812	-0.006	-0.691	0.003	0.687
$\Delta log(UCC_{it-4})$	-0.006	-0.981	0.006	0.963	-0.001	-0.360
$\Sigma\Delta log(UCC_{it-j})$	*-0.097**	*-1.949*	*-0.099*	*-1.293*	*0.022*	*0.985*
$cash_{it}/K_{it-1}$	0.086	1.060	0.361***	4.166	0.386***	4.274
$cash_{it-1}/K_{it-2}$	0.110***	3.036	-0.044	-1.644	0.000	0.012
$cash_{it-2}/K_{it-3}$	0.024	1.221	-0.046***	-2.880	-0.001	-0.041
$cash_{it-3}/K_{it-4}$	-0.025	-1.265	-0.018	-1.394	0.008	0.591
$cash_{it-4}/K_{it-5}$	0.005	0.238	0.014	1.042	-0.020	-1.537
$\Sigma\, cash_{it-j}/K_{it-j-1}$	*0.200****	*3.479*	*0.266****	*4.375*	*0.374****	*6.826*
	statistic	p-value	statistic	p-value	statistic	p-value
Sargan	121.649	0.568	114.515	0.739	130.063	0.360
Wald - lag 4	13.609	0.009	26.003	0.000	6.849	0.144
m1	-15.658	0.000	-19.145	0.000	-34.795	0.000
m2	1.351	0.177	-1.782	0.075	-1.873	0.061
# obs # firms	14856	3040	25444	4648	88220	16954

2nd step GMM Arrelano-Bond estimates of the investment equation (4) over 1991-1998
the constant and time dummies are not shown
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Overall, the results suggest that large-firm investment is smoother, depends on fundamentals (value added growth, i.e. the accelerator model) and is less determined by cash flow. Due to stronger financial constraints, small firms might invest once they have the opportunity and available financing, and then wait for some time for new investment opportunities and funding. Our results also highlight very strong investment-cash flow sensitivity for small service firms, as opposed to large service firms. Differences in the degree of financial constraints is a necessary condition for the credit channel to be operative. Our results therefore indicate that the credit channel may be a relevant channel of transmission of monetary policy. Finally, an other important result for the analysis of monetary policy is that user cost fluctuations have stronger effects in the construction sector than in the manufacturing sector and no effect on service firms. Since, the interest rate channel affects investment through changes in the user cost of capital, the evidence of significant user cost effects is a preliminary indication that this channel may be important for monetary policy. In sum, depending on the sector, we find evidence that both interest rate and credit channel are relevant.

In Butzen et al (2001), we check the robustness of our results with respect to outlier trimming. We estimate our model for a sample trimmed according to another methodology. We trim over the same variables but consider a range of values defined by a multiple of the median absolute deviation from the median (MAD), rather than by the percentiles. This criterion is more robust to outliers and yields a more symmetric distribution; we adopted a conservative threshold[21]. Although the order of magnitude of the coefficients may differ in the two samples, most of our conclusions remain valid.

Finally, we compare our results with the existing empirical evidence. Comparisons, however, are often not straightforward since many papers in the literature only focus on large manufacturing firms, and estimate a different model of investment (e.g. omit the user cost, or prefer an Euler equation instead of an ADL model). First, our finding of a stronger cash flow sensitivity for small firms appears to be consistent with the evidence, provided in several papers, that small firms face stronger financial constraints. For Belgium, Tychon (1997) indicates that large Belgian firms rely less on bank debt, while small Belgian firms are dominated by internal financing. Vermeulen (2002), and also Cincera (2002) also obtain higher cash flow sensitivities for small firms. With respect to differences in the user cost sensitivity across firms, Gérard and Verschueren (2002) show that small Belgian firms are more sensitive. Using a different methodology, in a previous study, Gérard and Verschueren (2000) also find differences in the long-run user cost elasticity of investment across Belgian industries.

As for other EU member states, Kremp and Stöss (2000) find that small German firms are more credit-dependent than large ones. Guiso (1997) shows that the probability of being credit-constrained decreases with size for Italian high-tech firms. For Italy, Gaiotti

[21] The sample is half the interpercentile sample, for all sectors and sizes.

and Generale (2001) find that small firms have greater sensitivity with respect to the user cost and cash flow. The same result applies for firms with less tangible assets (which implies less collateral). For France, Chatelain and Tiomo (2001) obtain evidence that equipment goods firms, firms with a low trade credit share and risky firms are more sensitive to cash flow than other firms. For Germany, von Kalckreuth (2001) show that firms with a high credit rating are less sensitive to cash flow and more sensitive to the user cost, and that small firms are more sensitive to the user cost (although not significantly so). For Austria, the results of Valderrama (2001) reveal that firms which have a house bank are less sensitive to cash flow but more sensitive to the user cost. For Luxembourg, Lünnemann and Mathä (2001) find that young firms are more sensitive to cash flow, the user cost and sales growth. In sum, our results are in line with other evidence for Belgium and for other EU countries.

5. Effects of Monetary Policy on Investment

5.1. Identification issues

In this section, we evaluate the effects of an interest rate change on firms' investment decisions that operate through the major channels of monetary transmission. The previous section, so far, has only highlighted that the user cost of capital, sales and cash flow are all important determinants of firms' investment behaviour. We still need to assess the impact of a change in the policy-controlled interest rate on these fundamentals. Moreover, our exercise involves some identification issues with respect to the transmission channels as well as with respect to monetary policy, which need some further clarification.

As we already noted, a change in the monetary policy stance may affect firms' investment through many different channels. First, the common positive effect on the firm-specific interest rate of all firms which is triggered by an increase in the market interest rate is the so-called interest rate channel. Second, an increase in the interest rate may deteriorate firms' balance sheet positions. It reduces cash flow by increasing interest payments. It also reduces the value of assets that may be used as collateral. In a world of asymmetric information and moral hazard, this aggravates credit constraints problems. Consequently, the external finance premium charged by lenders to the firms may go upwards. Some firms may even become credit rationed and have to rely solely on internal resources[22]. This is the credit channel. Third, as monetary policy affects demand for goods, an interest rate increase may also affect firms' investment through a reduction in sales.

[22] In this case, the investment-cash flow sensitivity could increase in response to a monetary contraction. This feature is used by Oliner and Rudebusch (1996) to identify the credit channel. Although this may be an interesting issue, we do not consider it. Investigating potential asymmetric effects of monetary policy on firms investment is beyond the scope of this paper. Constructing an indicator of monetary policy stance, as they do, always depends on the identification assumptions made about monetary policy. Another strategy is to use time-varying parameters estimation, as is sometimes done in the business cycle literature. However, since we use annual data, the identification of episodes of tight/loose monetary policy is likely to be very poor.

We do not consider the third channel in this paper. The simulations of Gaiotti and Generale (2001) and Chatelain et al (2001) suggest that this channel may be of little importance in the transmission of monetary policy to firms' investment. Therefore, ignoring potential effects through sales changes should not lead to a substantial under-evaluation of the effects of monetary policy. As for the two remaining channels, disentangling the interest rate from the credit channel is a challenging task because the credit channel operates both through changes in available cash flow and through changes in the external finance premium embedded in the user cost of capital. Changes in the user cost of capital following an interest rate change may be attributed to both the interest rate and credit channel. The change that is related to the interest rate channel should be identical for all firms, while the change that may be attributed to the credit channel should vary across firms according to their financial position. In order to measure the interest rate channel, we fix the elasticity of the firm-specific interest rate with respect to the market interest rate to 1 for all firms[23]. We do not consider the change in firm-specific interest rate that is related to the credit channel[24]. Therefore in this paper we evaluate the effect of monetary policy changes on firms' investment through the interest rate channel and through the part of the credit channel that operates via a reduction in available cash flow.

Another identification issue is that of monetary policy. Several approaches have been followed in the literature. First, "the naive approach" relates changes in monetary policy to changes in the real interest rate. This does not disentangle endogenous (with respect to the business cycle, for example) from exogenous monetary policy actions. Second, an extensive literature tries to identify exogenous monetary policy shocks, using structural VARs for example; this is "the structural approach". The resulting shocks depend on the identification assumptions chosen. This strategy is in general applied to quarterly data. Third, "the narrative approach" consists in dating periods of stringent or loose monetary policy from the readings of the minutes of the monetary policy council. We consider the naive approach, and so, evaluate the effect of an interest rate change on firms' investment. In addition to its simplicity, the advantage is that we can easily construct the response of firms' user cost and cash flow to an interest rate change, while we would have to make additional identification assumptions using the other approaches, thereby multiplying sources of errors.

[23] Since the time dimension of our panel is relatively short, we prefer to fix rather than estimate this coefficient. By doing so, on the one hand, we avoid using imprecise estimates due to low degrees of freedom. On the other hand, we assume immediate adjustment of the firm-specific interest rate to changes in the market interest rate, contrary to von Kalckreuth (2001). He uses information on debt maturity embedded in his measure of the user cost to estimate the reaction of the user cost over several years. Our measure of the user cost does not permit such a decomposition. Note that, since the effect is equal for all firms, the value of this elasticity affects the magnitude of the total effect of an interest rate change on the capital stock, but not the ranking of this effect across groups.

[24] This would require that we know or estimate both the reaction of the firm-specific interest rate to the market interest rate that is common to all firms, and the reaction that depends on the financial structure of each firm. As explained in the preceding footnote, the time dimension of our sample may be to short to consistently estimate the former. The estimation of the later requires the use of a relevant proxy for financial constraints. Although important, we leave this point for future research.

5.2. ASSESSING THE EFFECTS OF A TRANSITORY INTEREST RATE CHANGE ON FIRMS' INVESTMENT

In this section, we evaluate the relative importance of both channels. For that purpose, we simulate the effect of a transitory change in the market interest rate on the user cost of capital and the cash flow-capital ratio, and thereby on investment. Comparable exercises may be found in Chatelain et al (2001) for major euro area countries, Gaiotti and Generale (2001) for Italy, and von Kalckreuth (2001) for Germany. In the last part of their paper, Gérard and Verschueren (2002) also simulate the impact of an interest rate change on firms' investment through the user cost of capital in Belgium. We use our estimates of the dynamic equation for investment together with an evaluation of the effect of a transitory interest rate change on the user cost of capital growth rate and on the cash flow-capital ratio. We simulate the effect of a transitory 100 basis points increase in the short-term market interest rate in period t; the interest rate returns to its initial value in t+1. We assume that this leads to a 100 basis points increase in the firm-specific interest rate, and omit potential effects on the external finance premium, as explained above. From the definition of the user cost of capital, this induces the following changes in the user cost of capital

$$\text{in t, } \Delta UCC_{it} = \frac{P^I_{st}}{P_{st}}\text{; in t+1, } \Delta UCC_{it+1} = -\frac{P^I_{st+1}}{P_{st+1}}\text{; in t+n, } \Delta UCC_{it+n} = 0 \text{ for all n>0} \quad (6)$$

Given that cash flow is equal to sales minus interest charges (which is equal to the firm-specific interest rate times debt) minus other costs, we assume that the effect on the cash flow-capital ratio is equal to[25]:

$$\text{in t, } \Delta\frac{cash_{it}}{K_{it-1}} = -\frac{debt_{it}}{K_{it-1}}\text{; in t+1, } \Delta\frac{cash_{it+1}}{K_{it}} = \frac{debt_{it+1}}{K_{it}}\text{; in t+n, } \Delta\frac{cash_{it+1+n}}{K_{it+n}} = 0 \text{ for all n>0} \quad (7)$$

We approximate these expressions by taking the mean values by sector and size of the price ratio and the debt-capital ratio. Using the estimates of the dynamic equation for investment given in the previous section, we can now simulate the effect of an interest rate change on firm investment. Table 5 reports the contemporaneous and three-years cumulated effect of an interest rate change on the investment-capital ratio by sector and size. It distinguishes between the effects that operate through the user cost and those through the cash flow-capital ratio. The former is associated to the interest rate channel and the latter to the credit channel. Except for the service sector, we find, as in Chatelain et al (2001),

[25] By doing so, we assume that the cash flow-capital ratio is not affected by changes in the capital stock due to changes in the investment rate. This is not purely correct. However, we consider that the assumption that the cash flow-capital ratio remains constant in the long-run is reasonable. Another strategy would require to evaluate or postulate the adjustment of the cash flow after the interest rate change (after t+1) in order to obtain the pattern of the cash flow-capital ratio. We also ignore potential effect of an interest rate change on inflation and sales, and potential simultaneity between the determinants of investment. See von Kalckreuth (2001) and Chatelain et al (2001) for a similar approach. Gaiotti and Generale (2001) use the results of the quarterly macroeconomic model of the Banca d'Italia to asses the effect of monetary policy on investment determinants.

Gaiotti and Generale (2001) and von Kalckreuth (2001), that the effect of an interest rate change on investment is largely due to changes in the user cost. Indeed, the interest rate channel accounts for 75% of the change in the investment rate in the first year and above 95% after three years. However, this result should be moderated by the fact that we did not take into account the part of the credit channel that operates through changes in the external finance premium.

In addition to the above mentioned papers, our sample allows us to analyse the effects of monetary policy both across sectors and size. Our results suggest that the interest rate channel produces stronger effect on small manufacturing firms than on large manufacturing firms. However, the reverse is true for construction after three years (but this sector accounts for a small part of GDP), and the interest rate channel has no effect on service firms. We also find that small manufacturing firms suffer more from a monetary contraction than large manufacturing firms do, both through the interest rate and credit channel. Construction firms suffer more from a monetary contraction than firms of other sectors. For all sectors, the credit channel is stronger for small firms, which reflects the stronger investment-cash flow sensitivity of small firms.

Finally, firms of the service sector differ strongly from manufacturing and construction firms. The estimates of the previous section have shown that service firms do not react to user cost changes, so that the interest rate channel is not effective in this sector. In addition, Table 5 reveals that the effects that operate through cash flow are much larger for service firms than for firms of other sectors. However, the total effect of monetary policy on investment is low, and even close to zero after three years, because of the insignificance of the interest rate channel.

TABLE 5: CUMULATED EFFECT OF A ONE-YEAR INTEREST RATE INCREASE ON THE INVESTMENT-CAPITAL RATIO

	Manufacturing		Construction		Services	
	large firms	small firms	large firms	small firms	large firms	small firms
Cumulated effect of a one-year interest rate increase through changes in the user cost of capital						
t	-0.097	-0.199	-0.255	-0.449	0.145	0.072
t+3	-0.184	-0.298	-0.494	-0.264	0.098	0.101
Cumulated effect of a one-year interest rate increase through cash flow						
t	-0.032	-0.052	-0.100	-0.219	-0.163	-0.304
t+3	-0.032	0.019	0.007	0.019	-0.074	-0.002
Total cumulated effect of a one-year interest rate increase						
t	-0.129	-0.250	-0.355	-0.668	-0.019	-0.232
t+3	-0.216	-0.279	-0.487	-0.246	0.025	0.100

source: authors' calculations combining equations (6), (7) and the estimates of Tables 3 and 4.

5.3. THE LONG-RUN EFFECT OF MONETARY POLICY ON FIRM'S CAPITAL STOCK THROUGH THE INTEREST RATE CHANNEL

The results above indicate that the interest rate channel is the major monetary transmission channel. In this section we assess the magnitude of this channel for firms' capital stock. Our estimates of the investment equation also allow us to estimate the long-run elasticity of the stock of capital to the user cost of capital. Combining this with the long-run elasticity of the user cost of capital with respect to the firm-specific interest rate, and focusing on the cases in which we assume that the long-run elasticity of the firm-specific interest rate to the market interest rate is equal to 1 for all firms, we obtain the long-run elasticity of capital with respect to the market interest rate through the interest rate channel. Indeed, the long-run elasticity of capital to the market interest rate is equal to:

$$\varepsilon_{r_t}^{K_{it}} = \varepsilon_{UCC_{it}}^{K_{it}} . \varepsilon_{i_{it}}^{UCC_{it}} . \varepsilon_{r_t}^{i_{it}} \tag{8}$$

where ε_y^x is the long-run elasticity of x with respect to y, i_{it} is the firm-specific interest rate and r_t, the short-term market interest rate. This expression consists of three elements. The first element is the long-run elasticity of capital with respect to the user cost and is given by the estimates in the previous section. The second element represents the elasticity of the user cost with respect to the firm-specific interest rate, and this can be derived analytically (from the definitions of the user cost given in Appendix A.2):

$$\varepsilon_{i_{it}}^{UCC_{it}} = \frac{i_{it}}{i_{it} + \delta_i - (1-\delta_i).\frac{\Delta P_{st+1}^I}{P_{st}^I}} \tag{9}$$

where δ_i is the firm-specific depreciation rate and PI_{st} the sector-specific deflator on gross capital formation. If we accept that the user cost definition holds on average, we can approximate the elasticity by taking mean values (by sector and size) of expressions (9). Finally, rather than estimating the third element - the elasticity of the firm-specific interest rate to the market interest rate- we postulate it to be 1[26].

Table 6 reports the different elasticities used in equation (8). In addition to a stronger elasticity of capital with respect to the user cost of capital (especially in the manufacturing sector, as shown in Section 4), small firms also have a higher elasticity of the user cost of capital to the market interest rate. Therefore, small firms cut their capital stock more sharply following an interest rate increase than large firms do. Apart from service firms which do not respond to changes in the user cost, a 1% interest rate increase, so e.g. from 5% to 5.05%, leads to a reduction in the capital stock of around 0.01% to 0.02% for large firms to around 0.03% for small firms. The effect of the interest rate channel also differs across sectors. For large firms, the effect is stronger in the construction sector.

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[26] See footnote 23.

TABLE 6: THE LONG-RUN EFFECTS OF THE INTEREST RATE CHANNEL ON THE STOCK OF CAPITAL

	Manufacturing	Construction	Services
elasticity of capital with respect to the user the user cost of capital			
large firms	-0.032	-0.093	0.013
small firms	-0.088	-0.086	0.022
elasticity of the user cost of capital with respect to the market interest rate			
large firms	0.304	0.232	0.185
small firms	0.403	0.347	0.335
long-run elasticity of capital with respect to the market interest rate			
large firms	-0.010	-0.022	0.002
small firms	-0.035	-0.030	0.007

source: authors' calculations combining the estimates in Tables 3 and 4 and equation (9)

Our outcome for the Belgian manufacturing sector is consistent with Wesche 's (2000) results for Austria, and with Ehrmann 's (2000) conclusions for Germany, derived from a structural VAR analysis. Other panel data studies also highlight distributional effects of monetary policy. In particular Gaiotti and Generale (2001), for Italy, and von Kalckreuth (2001), for Germany, point to differences across firms of different size.

6. CONCLUSION

This paper investigates some of the effects of monetary policy on firms' investment behaviour. We confine our analysis to effects that operate through the interest rate and credit channels of monetary policy.

The analysis relies on the use of a comprehensive database of Belgian firms over the period 1985-1998, covering all sectors of economic activity, and firms of all sizes. This database enables us to investigate this issue for each sector and for large and small firms separately. Taking into account the heterogeneity among firms enables us to avoid possible aggregation biases and to find evidence for distributional effects of monetary policy across sectors and sizes. We proceed in two steps. First, we estimate an ADL(4) version of a reduced-form investment equation, derived from the neo-classical model, including the firm-specific user cost of capital and augmented with cash flow. This equation is estimated with the Arrelano and Bond (1991) first difference GMM procedure. Second, we evaluate the effect of a change in the policy-controlled interest rate on the user cost and on cash flow, in order to assess the relative importance of the interest rate and credit channels across groups of firms.

We split our sample into three broad sectors of economic activity - manufacturing, construction and services - and two size classes. Our results for the first step point to size and sector differences in the investment behaviour of Belgian firms. Large firms tend to smooth investment, while small firms' investment is characterised by lumpy dynamics. Investment-cash flow sensitivity is larger for small firms; this might be interpreted as evidence of stronger financial constraints. Such an interpretation is supported by evidence of worse financial conditions for small firms. So, due to stronger financial constraints, small firms might invest once they have the opportunity and available financing, and then wait for some time for new investment opportunities and funding. Our estimates also highlight differences across sectors. Investment-cash flow sensitivity is particularly high for small service firms, and very low for large service firms. Again, this corresponds to a better financial situation for large service firms and may be interpreted in terms of the degree of financial constraints. So our results points to the existence of different degree of financial constraints according to the size and sector considered. This suggests that the credit channel may be a relevant transmission mechanism of monetary policy. An other important result for the analysis of monetary policy is that user cost fluctuations have stronger effects in the construction sector than in the manufacturing sector, and no effect on service firms. This implies that the importance of the interest rate channel may also vary across size and sectors.

In the second step of our analysis, we evaluate the effect of an interest rate change on firms' investment. First, we simulate the effect of a transitory 100 basis-points interest rate increase on firms' investment rate. We evaluate separately the effect that may be attributed to the interest rate channel, and the effect that reflects (part of) the credit channel. Our simulation shows that the interest rate channel accounts for most of the monetary transmission mechanism to investment. However, this result should be moderated by the fact that we did not take into account the part of the credit channel that operates through changes in the external finance premium. Consistently with our findings of stronger financial constraints for small firms, we find that the credit channel is more important for small firms, in all sectors. Our results also suggest that the construction sector is the most affected by variations in the interest rate, and that the service sector is the most affected by the credit channel but is insensitive to the interest rate channel so that it suffers the less form a monetary contraction.

Finally, we calculate the long-run elasticity of the user cost of capital with respect to the market interest rate, that is attributable to the interest rate channel. Our computations confirm that small firms reduce their capital stock to a greater extent following a monetary contraction. They also show that the reaction of large construction firms is much stronger than that of large manufacturing firms, and that monetary policy has no effect on large service firms.

In sum, our results support the hypothesis of an interest rate and credit channel in Belgium. We find evidence that small firms are more sensitive to monetary policy than large firms, that construction firms are more sensitive than other sectors. The interest rate channel appears to be the dominant channel of monetary transmission for the manufacturing and construction sectors. It accounts for 75% of the first-year effect of an interest rate change. As investment of service firms are unsensitive to the user cost of capital, the interest rate channel is inoperative in this sector. On the contrary, the credit channel has large effects in the short and medium run, especially for small service firms. The impact of the interest rate and credit channels differs across sectors and sizes.

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APPENDIX

APPENDIX A : DATA

A1. SAMPLE SELECTION AND REPRESENTATIVENESS OF THE SAMPLE

From the original annual accounts database of the National Bank of Belgium we construct our sample in several steps. First, we eliminate annual accounts of public companies and of non-profit associations. This leaves us with a sample of profit-maximising firms (i.e. 99.7% of the original database). Second, we retain only the firm-years with strictly positive total assets, fixed assets and depreciation rate. Annual accounts that do not meet this requirement may be consistent purely accounting-wise, but are usually submitted by firms that are close to bankruptcy. The remaining observations represent around 90% of the original database. Third, we impose that all variables (investment-capital ratio, cash flow-capital ratio, user cost of capital and value added) are available, not only in levels but also in first differences. This means that for each firm there must be at least two consecutive annual accounts and that user cost of capital and value added variables must be strictly positive, since they appear in logarithm form in the equation. This reduces our sample to less than 50% of the original database. Fourth, we trim the variables for outliers by dropping the first and the 99th percentile of the level and first difference. We perform the trimming on a year by year basis, and for small and large firms separately[27]. After trimming there remains 43% of the original database. Finally, we select only those firms with enough consecutive annual accounts to enable the ADL(4) model to be estimated. Because the model is estimated in differences, we need at least seven consecutive years. This leaves us with around 12 % of the original database.

TABLE A.1: SUMMARY STATISTICS OF THE SAMPLE

large firms	mean	std. dev.	maximum	75%	median	25%	minimum
I/K	0.169	0.233	3.007	0.208	0.107	0.045	-0.266
Dlog VA	-0.013	0.323	5.708	0.106	0.004	-0.105	-7.984
Dlog UCC	-0.009	0.559	3.498	0.232	0.011	-0.263	-3.239
CF/K	0.346	0.657	15.834	0.379	0.216	0.124	-2.263
log VA	14.692	1.280	21.661	15.359	14.576	13.907	6.419
log UCC	-2.006	0.567	1.144	-1.685	-1.976	-2.312	-4.886
small firms	**mean**	**std. dev.**	**maximum**	**75%**	**median**	**25%**	**minimum**
I/K	0.194	0.344	5.750	0.227	0.093	0.029	-0.287
Dlog VA	-0.056	0.413	5.430	0.111	-0.018	-0.170	-8.157
Dlog UCC	-0.007	0.474	3.040	0.213	0.009	-0.227	-2.662
CF/K	0.235	0.283	5.239	0.298	0.181	0.102	-1.044
log VA	11.991	1.224	16.266	12.861	12.048	11.208	3.168
log UCC	-1.777	0.558	0.857	-1.471	-1.777	-2.106	-4.348

[27] Our procedure is stricter than the standard practice in the literature, where outlier selection is done on the whole sample, or, at best, on a yearly basis only. Size is, however, the outstanding feature, which can substantially influence the trimming results. Table A.1 gives an idea of the distributional differences according to size

To have an idea of the representativeness of our final sample, note that in terms of both value added and employment our final sample represent around 44% of the profit-maximising sample and 20% of aggregate economic activity as given in the national accounts. There is a small bias towards large firms. However, the number of small firms still remains quite large. As shown in Table A.2, more than 40% of firms hire at most five employees. Note that the proportion of large firms is highest in the manufacturing sector.

TABLE A.2 : NUMBER OF EMPLOYEES IN THE FINAL SAMPLE OVER 1991-1998

	all firms	manufacturing	construction	services
average	34	87	19	24
median	7	16	7	6
fewer than 1 employee	10.79%	4.41%	7.32%	13.21%
fewer than 5 employees	44.05%	24.13%	40.46%	49.78%
fewer than 10 employees	62.84%	39.98%	61.67%	68.55%
fewer than 50 employees	92.38%	79.66%	93.43%	95.11%

fewer than x employees stands for the percentage of firms with less than x employees,

In terms of sectors, Table A.3. reports the sector share in total value added and employment as reported in the national accounts, in the sample of profit maximising firms and in our final sample. Comparing the share of the national accounts with those of our final sample indicates that manufacturing and construction may be somewhat over represented. This would weaken our conclusions if our analysis pooled all firms together. However, since we analyse separately firms of different sectors and size groups, this should not be harmful for our results.

TABLE A.3: COMPARISON OF THE RELATIVE IMPORTANCE OF SECTORS IN 1995 IN THE NATIONAL ACCOUNTS, IN THE PROFIT-MAXIMISING SAMPLE AND IN THE FINAL SAMPLE

	sector share in value added			sector share in employment		
	national	profit-maximising accounts (1)	final sample sample	national accounts (2)	profit-maximising sample	final sample
agriculture	1.5	0.5	0.0	2.5	0.7	0.0
industries	21.7	44.5	50.1	19.7	38.4	41.4
energy	2.9	4.2	6.4	0.9	1.7	2.7
manufacturing	18.9	40.4	43.8	18.8	36.7	38.8
construction	4.8	7.1	7.7	6.6	10.0	10.9
commercial services	52.2	47.7	42.2	51.9	50.7	47.6
others	9.8	0.1	0.0	9.4	0.2	0.0

(1) source: the Institute for National Accounts
(2) source: the National Office for Employment

Finally, since the use of a dynamic model and estimation in first differences is very costly in terms of the number of observations lost, there might also be a concern that we are only analysing the investment behaviour of mature firms. In Butzen et al (2001), we calculated the median and median absolute deviation from the median for the final sample and the profit-maximising sample. These statistics are very close for our variables in both samples[28]. We can thus conclude that our selection has not introduced a pronounced representation bias.

A2. Construction of the variables

We define the variables as follows; numbers in brackets represent the annual accounts codes for the corresponding variable. Since annual accounts of small and large firms report different information, the definition of the variables may differ for small and large firms. We use 2-digit NACE codes for investment and value-added prices aggregated for 23 sectors.

The computation of the capital stock is based on the perpetual inventory method, i.e., applying the following formula

$$P^I_{st}K_{it} = (1-\delta_i)P^I_{st-1}K^I_{it-1}(P^I_{st}/P^I_{st-1}) + P^I_{st}I_{it} \qquad (a1)$$

with K_{it} representing the real capital stock, P^I_{st} the sector-specific deflator on gross capital formation and δ_i the firm-specific depreciation rate[29]. The initial nominal capital stock is given by the book accounting value of the capital stock (8159), plus revaluation gains (8209), minus depreciation and amounts written down (8269), all at the end of the preceding period. The firm-specific depreciation rate was estimated as the median depreciation expenditures on capital, over the years in which the firm exists.

The user cost of capital takes into account forward-looking expectations. It is based on the firm-specific interest rate, i_{it}. The firm-specific interest rate is defined as the ratio of financial charges (we consider financial charges (65) for small firms, and debt charges (650) for large firms) minus interest subsidies (9126) over (financial and other) debt (42+43+47/48+170/4+178/9)[30]. We do not incorporate taxes in the definition of the user cost, although we do subtract interest subsidies from debt charges in the definition of the user cost. Our expression for the user cost is daily standard:

[28] Of course, the final sample has a lower dispersion than the initial one owing to the focus on the interpercentile range, and it is more symmetric for all variables, especially for the investment rate and cash flow. But the median is almost unaffected.

[29] The capital stock at time t results from investments undertaken over different periods. Therefore, using current investment prices to deflate the nominal capital stock is not correct. The perpetual inventory method allows to circumvent this problem, except for the initial stock, K_{i0}.

[30] So we excluded trade debt (44), amounts payable within advances received on orders in hand (46) and amounts payable within taxes, remuneration and social security (45) from short-term debt, and we excluded trade debt (175) and amounts payable after advances received on contracts in progress (176) from long-term debt.

$$UCC_{it} = \frac{P^I_{st}}{P_{st}} \left[i_{it} + \delta_i - (1 - \delta_i) \frac{\Delta P^I_{st+1}}{P^I_{st}} \right] \tag{a2}$$

where PI_{st} is the sector-specific deflator on gross capital formation and P_{st} is the sector-specific value-added price. Our measure of the user cost of capital is based on the firm-specific interest rate, rather than on the market interest rate. The advantage of our measure is that it is closer to the true firm-specific user cost of capital, because it implicitly takes into account microeconomic factors such as interest rate subsidies, or firm-specific risk and external finance premiums which may arise, for example, because firms are in a riskier sector, are younger, etc. This turns out to be of sizeable importance. Indeed, Table 2 in section 3 shows very high differences between the firm-specific interest rate of small and large firms, pointing to non negligible risk and external finance premia. Further, the firm-specific interest rate explains a large part of the user cost of capital heterogeneity[31]. The main disadvantage of this measure is that it measures the average user cost of capital (i.e. the cost of existing capital) rather than the marginal user cost of capital (i.e. the cost of new capital), which may be more relevant for investment decisions.

Cash flow is defined as follows. Basically, interest payments enter linearly in this definition. This feature will be used in the simulations of the effect of an interest rate change on investment through cash flow. For large firms, it is equal to the sum of

profit or loss for the period (70/67 or 67/70)

\+ depreciation of and other amounts written off formation expenses, intangible and tangible (630)

\+ amounts written down, loan issues expenses and repayment premiums (6501), amounts written off current assets other than those mentioned under II. E. (651), and provisions of a financial nature (6560+6561)

\+ extraordinary depreciation of and extraordinary amounts written off formation expenses, intangible and tangible fixed assets (660), amounts written off financial fixed assets (661), provisions for extraordinary liabilities (662) and losses on disposal of assets (663)

\+ amounts written off stocks, contracts in progress and trade debtors (631/4)

\+ provisions for liabilities and charges (635/7)

\+ accumulated amounts written off on amounts receivable at the end of the period, recorded or written back because surplus (8471+8472+8473+8481+8482+8483)

\- net book value at the end of the preceding period of amounts payable for taxes, remunerations, amounts written down (8601+8602+8603) and amounts written back (8611+8612+8613)

\- extraordinary income : adjustments to depreciation of and to other amounts written off intangible and tangible fixed assets (760), adjustments to amounts written off

[31] The standard deviation of the user cost of capital over our sample is almost three times larger when it is based on the firm-specific interest rate than on the market interest rate.

financial fixed assets (761), adjustments to provisions for extraordinary liabilities and charges (762)

- \+ losses on disposal of realised assets (663)
- \- capital subsidies granted by public authorities and recorded as income for the period (9125)
- \- transfer from deferred taxes (780) - transfer to deferred taxes (680)

For small firms, cash flow is constructed as:

profit or loss for the period (70/67 or 67/70)

- \+ amounts written off stocks, contracts in progress and trade debtors (631/4)
- \+ provisions for liabilities and charges (635/7)
- \+ interests recorded under assets : provisions of a financial nature (656)
- \+ depreciation and amounts written down : movements during the period recorded for intangible (8079), tangible (8279) and financial (8475) assets
- \+ depreciation and amounts written down : movements during the period written back because surplus for intangible (8089), tangible (8289) and financial assets (8485)
- \- capital subsidies granted by public authorities and recorded as income for the period (9125)
- \- transfer from deferred taxes (780) - transfer to deferred taxes (680)

Value added is expressed in real terms. For large firms, nominal value added is equal to operating income (70/74) minus operating subsidies and compensatory amounts received from public authorities (740), and the following operating charges: raw materials consumables (60) and services and other good (61). For small firms, valued added is proxied by gross operating margin (70/61 or 61/70).