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Université Catholique de Louvain

1998

ELSEVIER

Economic Modelling 15 (1998) 67–89

Economic Modelling

Internal finance and corporate investment: Belgian evidence with panel data

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Abstract

In this paper the corporate investment decision under financial restrictions is investigated with Belgian firm data from 1984 to 1992. An investment Euler equation is derived from a dynamic optimization model with debt ceilings and an elastic credit supply. The model is estimated by GMM for different firm groups. An important aspect is that the sample is split according to a firm's association with coordination centers. These centers have become the major external funding source of corporate investment in Belgium since 1986. The estimation results show the dependence of corporate investment on financial factors, both for non-coordination center as well as coordination center firms. © 1998 Elsevier Science B.V.

JEL classifications: C23; C52; D21; D92

Keywords: Investment; Uncertainty; Financial restrictions; Coordination centers

1. Introduction

Under the Modigliani and Miller (1958) conditions a firm's capital structure does not affect the firm's market value. In actual capital and credit markets the conditions imposed by Modigliani and Miller (1958) do not hold, debt finance is an important source of external funds, and the relation between debt and equity

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0264-9993/98/$19.00
PII S0264-9993(97)00021-7

finance seems important. Aspects in economies that do not satisfy the assumptions made by Modigliani-Miller concern the tax structures, costs of bankruptcy, differential borrowing rates, monitoring costs required to minimize risks and asymmetric information.

Recent developments in the literature on imperfect information in capital markets show that a firm's capital structure is chosen such that inefficiencies in a firm's investment decisions are mitigated, e.g. Myers and Majluf (1984). An important feature is the existence of asymmetric information. Entrepreneurs are assumed to have more information about the investment process, like the probability distribution of outcomes, than the lenders of funds. This generates a conflict of interests, like in the traditional agency problem, which either generates a wedge between the price of internal and external funds or eliminates sources of finance. The cost and ability to invest depend thus on the financial position, in particular on the internal net worth (e.g. Leland and Pyle, 1977).

If credit market imperfections limit a firm's access to external finance or make it more expensive, firm's liquidity and internally generated cash-flow can determine its actual capital investment. On the one hand, firms may prefer to finance investment by internally generated funds to (low-risk) debt and to equities. This is known as the 'pecking order' theory of finance, in which 'the firms prefer internal to external financing, and debt to equity if it issues securities' (Myers, 1984, p. 576). On the other hand, a greater value of internal worth can reduce the likelihood of being rationed (or increase the loan size). This is the case if banks do not use the interest rate as the (only) rationing vehicle, but also other characteristic(s) of the loan contract or loan customer such as risk characteristics of the customer, collateral, money put in the project by the customer, etc.

Financial patterns can vary across firms according to the differences in the (incentive-induced) costs they face in obtaining external finance. Firms subject to capital market frictions are more likely to rely on retained earnings and bank debt, than on direct credit. Investment decisions will thus be sensitive to fluctuations in internal net worth for this type of firm. Investigating financial effects on investment under capital market imperfections requires hence a focus on the investment behaviour of groups of firms with different financial characteristics.

In recent literature many empirical studies on investment behaviour have investigated the influence of the financial structure on investment decisions. Investment behaviour of groups of firms with different financial characteristics have been analyzed. Different criteria to obtain the more and less likely financially constrained groups, like dividend policy payment, maturity, bond ratings and size, have been used to split the firm samples. In Table 1 some panel studies are summarized. The groups that are found to be most constrained in each study are mentioned in the last column.

Despite the difference in degree of development of financial markets in the countries and in sample periods, one important conclusion of all these studies is that investment depends on financial positions, in particular for specific groups.

Like the studies mentioned in Table 1, this study concentrates on dynamic investment decisions under uncertainty and financial constraints. An investment

Table 1
Investment panel studies with financial constraints

Authors	Country	Period	No. of firms	Finding: investment is more constrained for firms that ...
Fazzari et al. (1988)	US	70–84	422	are young and pay low-dividend
Whited (1992)	US	72–86	325	do not have bond ratings
Bond and Meghir (1994)	UK	71–86	626	pay low or no dividends
Estrada and Vallés (1995)	Spain	83–92	1508	are 'small' and/or young
Van Ees et al. (1996)	Netherlands	83–92	427	have low-payouts
Barran (unpublished)	Belgium	84–92	436	are not associated with a CC

Euler equation is derived from a dynamic optimization problem with debt ceilings and an elastic credit supply. The model is estimated by GMM with a Belgian panel data set of 1984–1992 that is for the first time used for this purpose.

A particular aspect in this study is the focus on coordination centers. Coordination centers were created in Belgium in 1982 to attract foreign investors and stimulate domestic investment. These coordination centers have as an important role the channelling of funds among firms within a center. This group relationship is likely to mitigate the asymmetric information problems and can consequently facilitate external funds for a firm associated with a coordination center (a CC-firm, for short) in comparison with a non-CC firm. Coordination centers in Belgium thus render similar services to member firms as keiretsu's in Japan (see for instance Hoshi et al., 1991).

The aim of this paper is twofold. First, we investigate whether Belgian corporate investment is affected by its liquidity and internally generated cash-flows. Second, we investigate whether coordination centers mitigate the asymmetric information problems and thus reduce the sensitivity of investment to liquidity, cash flows and debt positions of member firms.

The outline of the paper is as follows. In Sec. 2 the econometric model is specified, its model solution is derived and the testing for financial restrictions is explained. In Sec. 3 GMM results are presented. In Sec. 4 some background information and descriptive statistics on the coordination centers in Belgium is given. In Sec. 5 GMM results for CC firms and non-CC firms are presented. Sec. 6 summarizes and concludes.

2. The model

In the first subsection a model is specified. The model is a neoclassical investment model where financial constraints are included, similar to Whited (1992), Hubbard et al. (1995), and Bond and Meghir (1994). In the second and third subsection the model solution and the method of testing for the financial restrictions are presented.

2.1. The model specification

Managers are assumed to maximize the market value of the firm. This criterium function is specified as

$$\max_{\{K_{i,t},N_{i,t},B_{i,t}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \prod_{s=0}^{t-1} \beta_{i,s}(d_{i,t} - S_{i,t}). \tag{1}$$

E_0 is the rational expectations sign where the information set contains the information until period 0, t a time index, $\beta_{i,s} \equiv 1/(1+\theta_{i,s})$ where $\theta_{i,s}$ is the nominal discount rate at the end of period s and $d_{i,t}$ the after tax dividends at time period t. $S_{i,t}$ is the value of new shares issued at time t. $d_{i,t}$ is parameterized as

$$\begin{aligned} d_{i,t} = {} & (1-\tau)[F(K_{i,t-1},N_{i,t}) - W_t N_{i,t} - \Psi(I_{i,t},K_{i,t-1}) - r_{i,t-1}B_{i,t-1}] \\ & + B_{i,t} - (1-\pi_t^{\varepsilon})B_{i,t-1} - P_{s,t}^{I} I_{i,t} + S_{i,t} \end{aligned} \tag{2}$$

where

τ = the corporate income tax rate;
$K_{i,t}$ = the capital stock of firm i at t;
$I_{i,t}$ = gross investment of firm i at time t;
$N_{i,t}$ = vector of variable factor inputs by firm i at t;
$B_{i,t}$ = the amount of (long and short term) real debt of firm i at t;
W_t = vector of real factor prices of firm i at t;
$r_{i,t}$ = the interest rate paid on debt at time t;
$P_{s,t}^{I}$ = the real sectoral investment price at time t;
π_t^{ε} = the inflation, measured as the product price change at time t.

In (2) $F(.)$ is the production function and $\Psi(.)$ the adjustment cost function. The production function is a function of capital at period $t-1$ and variable factor inputs at period t. For capital stock it takes thus one period to become productive. The production function is assumed to be concave and to satisfy further Inada assumptions. The adjustment cost function is assumed to be convex. It is thus costly to change the capital stock quickly.

Capital stock accumulates according to the standard capital accumulation rule, i.e.

$$K_{i,t} = I_{i,t} + (1-\delta)K_{i,t-1} \iff I_{i,t} = K_{i,t} + (\delta - 1)K_{i,t-1}, \tag{3}$$

where δ represents the constant economic depreciation rate.

In addition to the equality restrictions (2) and (3) a non-negativity restriction on dividends must hold. This is guaranteed by

$$d_{i,t} \geq 0, \tag{4}$$

and will be associated with the Kuhn-Tucker multiplier $\lambda_{i,t}$.Furthermore, a transversality condition is to be imposed on debt as

$$\lim_{T\to\infty} \prod_{s=0}^{T-1} \beta_{i,s} B_{i,T} = 0. \tag{5}$$

This restriction excludes the possibility to borrow money, in order to pay dividends, at the end of the time horizon.

The existence of credit market imperfections can constrain firms financially, either by means of credit rationing or by increases in the cost of debt. Because these two regimes can exist simultaneously for different firms or at different times for the same firm, we specify both. First, following Whited (1992) we assume that firms have a debt ceiling $B^*_{i,t}$. This is specified as

$$B_{i,t} \le B^*_{i,t}, \tag{6}$$

where $B^*_{i,t}$ is the maximum amount that the firm can borrow at time t. This constraint will be associated with the Kuhn-Tucker multiplier $\gamma_{i,t}$ in the model solution in the next section.

Second, as in Bond and Meghir (1994) and Estrada and Vallés (1995) we assume that each firm faces an elastic credit supply curve that is known to the firm. This curve can be specified as

$$r_{i,t} = r_{f,t} + \Omega(B_{i,t}, K_{i,t}, F_{i,t}), \tag{7}$$

where $r_{f,t}$ is the risk-free interest rate and $\Omega()(\ge 0)$ is a function that is to be specified further.

2.2. The model solution

The criterium function (1) is maximized subject to restrictions (2), (3), (4), (5), (6), and (7). As is common in these kind of models, the restriction (5) will be disregarded. The expressions for $d_{i,t}$ and $I_{i,t}$ given by (2) and (3), respectively, are thereafter substituted in the criterium function (1).

The Euler equations are then found by taking the derivative of the criterium function with respect to $N_{i,t}$, $K_{i,t}$ and $B_{i,t}$. They are given by

$$F_N(K_{i,t-1}, N_{i,t}) = W_t \tag{8}$$

$$\begin{aligned} E_t\, \beta_{i,t} \{ \frac{1+\lambda_{i,t+1}}{1+\lambda_{i,t}} [F_K(K_{i,t}, N_{i,t+1}) - \Psi_K(K_{i,t}, I_{i,t+1}) \\ + (1-\delta)\left(\Psi_I(K_{i,t}, I_{i,t+1}) + \frac{P^I_{s,t+1}}{1-\tau} \right) \\ - \frac{\partial r_{i,t}}{\partial K_{i,t}} B_{i,t}] \} = \Psi_I(K_{i,t-1}, I_{i,t}) + \frac{P^I_{s,t}}{1-\tau} \end{aligned} \tag{9}$$

$$\beta_{i,t}\left[1+(1-\tau)\left(r_{i,t}+\frac{\partial r_{i,t}}{\partial B_{i,t}}B_{i,t}\right)-\pi^{\varepsilon}_{t+1}\right]E_t(1+\lambda_{i,t+1})+\gamma_{i,t}=1+\lambda_{i,t}. \tag{10}$$

$\Psi_I(.)$ and $\Psi_K(.)$ are the first derivative of the adjustment cost function with respect to the first and the second argument, respectively.

From (10) it follows that

$$\beta_{i,t}\frac{1-\Lambda_{i,t}}{1+(1-\tau)\left(r_{i,t}+\frac{\partial r_{i,t}}{\partial B_{i,t}}B_{i,t}\right)-\pi^{\varepsilon}_{t+1}}\frac{1+\lambda_{i,t}}{1+E_t\{\lambda_{i,t+1}\}}\quad\text{where}\quad\Lambda_{i,t}\equiv\frac{\gamma_{i,t}}{1+\lambda_{i,t}} \tag{11}$$

Notice that if the assumption of risk neutrality and perfect capital markets holds, i.e. the required return on equity equals the after tax return on debt,

$$\theta_{i,t}=(1-\tau)\left(r_{i,t}+\frac{\partial r_{i,t}}{\partial B_{i,t}}B_{i,t}\right)-\pi^{\varepsilon}_{t+1}\quad\Leftrightarrow$$
$$\beta_{i,t}=\frac{1}{1+(1-\tau)\left(r_{i,t}+\frac{\partial r_{i,t}}{\partial B_{i,t}}B_{i,t}\right)-\pi^{\varepsilon}_{t+1}} \tag{12}$$

since $\beta_{i,t}\equiv 1/(1+\theta_{i,t})$. Then notice that this expression equals the expression for (11) where $\gamma_{i,t}=\lambda_{i,t}=E_t\{\lambda_{i,t+1}\}=0$.

Substituting (11) in (9) reduces the first order condition of capital to

$$\beta^{*}_{i,t}\{F_K(K_{i,t},N_{i,t+1})-\Psi_K(K_{i,t},I_{i,t+1})+(1-\delta)\left(\Psi_I(K_{i,t},I_{i,t+1})+\frac{P^{I}_{s,t+1}}{1-\tau}\right)$$
$$-\frac{\partial r_{i,t}}{\partial K_{i,t}}\}-\Psi_I(K_{i,t-1},I_{i,t})-\frac{P^{I}_{s,t}}{1-\tau}=\varepsilon_{i,t+1}$$
$$\text{where}\quad\beta^{*}_{i,t}\equiv\frac{1-\Lambda_{i,t}}{1+(1-\tau)\left(r_{i,t}+\frac{\partial r_{i,t}}{\partial B_{i,t}}B_{i,t}\right)-\pi^{\varepsilon}_{t+1}} \tag{13}$$

The unobserved terms in (13) are substituted by their realisations by which an error term, $\varepsilon_{i,t+1}$ with mean zero and uncorrelated with the information set available to the firm at time t, is added to the Euler equation. Note that if $\Lambda_{i,t}$ is set equal to zero, the error term contains

$$-\Lambda_{i,t}\left\{F_K(K_{i,t},N_{i,t+1}) - \Psi_K(K_{i,t},I_{i,t+1}) + (1-\delta)\right.$$
$$\left.\times\left(\Psi_I(K_{i,t}I_{i,t+1}) + \frac{P^I_{s,t+1}}{I-\tau}\right) - \frac{\partial r_{i,t}}{\partial K_{i,t}}B_{i,t}\right\} \tag{14}$$

Under perfect capital markets this is not a problem since $\gamma_{i,t} = \lambda_{i,t} = E_t\{\lambda_{i,t+1}\} = 0$. Thus, using financial variables as instruments in the estimations is valid since they are uncorrelated with the disturbance term $\varepsilon_{i,t+1}$. However, if financial markets are not perfect, $\Lambda_{i,t}$ will be different from zero and the financial variables cannot be used as instruments since they would be correlated with the residuals.[1] If the financial markets are not perfect, fixed investment and financial positions are not independent.

In order to estimate (13) we have to parameterize $F_K(K_{i,t},N_{i,t+1})$ and $\Psi(K_{i,t-1},I_{i,t})$. Under the assumption of linear homogeneity of the production function the equality

$$F(K_{i,t-1},N_{i,t}) = F_K(K_{i,t-1},N_{i,t})K_{i,t-1} + F_N(K_{i,t-1},N_{i,t})N_{i,t} \tag{15}$$

holds. In this expression F_K and F_N are the marginal productivity of capital at period $t-1$ and labour at t, respectively. Rewriting (15) and substituting (8) gives

$$F_K(K_{i,t-1},N_{i,t}) = \frac{F(K_{i,t-1},N_{i,t}) - \mu W_t N_{i,t}}{K_{i,t-1}} \tag{16}$$

where $\mu = 1$. Like in Whited (1992) μ is a parameter to be estimated in our model. This allows us to estimate the existence of market power. If there is no market power, $\mu = 1$ (see also Whited, 1992).

For the adjustment cost function the rather standard quadratic specification

$$\Psi(K_{i,t-1},I_{i,t}) = \frac{\alpha}{2}\left(\frac{I_{i,t}}{K_{i,t-1}} - c\right)^2 K_{i,t-1} \tag{17}$$

was chosen. The constant c is a target value geared towards $I_{i,t}/K_{i,t-1}$. The derivatives of the adjustment cost function are then given by

$$\Psi_I(K_{i,t-1},I_{i,t}) = \alpha\left(\frac{I_{i,t}}{K_{i,t-1}} - c\right) \tag{18}$$

$$\Psi_K(K_{i,t-1},I_{i,t}) = -(1-\delta)\Psi_I(K_{i,t-1},I_{i,t}) - \frac{\alpha}{2}\left[\left(\frac{I_{i,t}}{K_{i,t-1}}\right)^2 - c^2\right] \tag{19}$$

[1] In the following section this is shown by the rejection of the test for overidentifying restrictions, i.e. the Sargan test.

Substituting (18), (19) and (16) in (13) we get

$$\beta^*_{i,t}[\frac{F(K_{i,t},N_{i,t+1}) - \mu W_{i,t+1}N_{i,t+1}}{K_{i,t}} + \frac{\alpha}{2}\left(\frac{I_{i,t+1}}{K_{i,t}}\right)^2 + (1-\delta)$$
$$\times\left(\alpha\frac{I_{i,t+1}}{K_{i,t}} + \frac{P^I_{s,t+1}}{1-\tau}\right) - \frac{\partial r_{i,t}}{\partial K_{i,t}}B_{i,t}]$$
$$- \alpha\frac{I_{i,t}}{K_{i,t-1}} - \frac{P^I_{s,t}}{1-\tau} + c_{i,t} + f_i + s_t = \varepsilon_{i,t+1} \tag{20}$$

where $c_{i,t} \equiv \alpha c[1 - ((1-\delta) + c/2)\beta^*_{i,t}]$ and f_i is a (fixed) firm effect, s_t a time effect and $\varepsilon_{i,t+1}$ the forecast error.

2.3. Testing for the financial restrictions

As discussed previously, financial restrictions in intertemporal investment models have empirically been tested by means of (i) constraints on the level of debt (e.g. Whited, 1992) or (ii) by (specifications on) the cost of debt. In the econometric model presented in the previous section both aspects are incorporated by (6) and (7).

The degree of the debt level constraints is measured by $\gamma_{i,t}$ in (6). This parameter is the shadow value of internal funds. If $\gamma_{i,t} = 0$ the firm is not constrained. In this case $\Lambda_{i,t} = 0$ and $\beta^*_{i,t}$ equals the 'traditional' discount factor if additionally $\lambda_{i,t} = E_t\{\lambda_{i,t+1}\} = 0$. If a firm is debt constrained, $\gamma_{i,t} > 0$.

Note also that $\lambda_{i,t} = E_t\{\lambda_{i,t+1}\} = 0$ does not necessarily mean that firms that pay dividends are not debt-constrained. If the opportunity costs of cutting dividends is higher than the shadow value of internal funds, dividends will be paid even if the firm is debt-constrained (see also Bond and Meghir, 1994).

As the shadow values $\lambda_{i,t}$ and/or $\gamma_{i,t}$ cannot be estimated directly, a specification is needed. As in Whited (1992), we assume that $\Lambda_{i,t}$ depends on financial variables that measure the financial distress of the firm. We adopt the specification

$$\Lambda_{i,t} = c_1\left(\frac{B_{i,t}}{L_{i,t}}\right) + c_2\left(\frac{B_{i,t}}{L_{i,t}}\right)^2 + c_3\left(\frac{r_{i,t}B_{i,t}}{r_{i,t}B_{i,t} + CF_{i,t}}\right) + c_4\left(\frac{r_{i,t}B_{i,t}}{r_{i,t}B_{i,t} + CF_{i,t}}\right)^2$$
$$+ c_5\left(\frac{B_{i,t} - F_{i,t}}{K_{i,t}}\right) + c_6\left(\frac{B_{i,t} - F_{i,t}}{K_{i,t}}\right)^2 + \varepsilon^{\Lambda}_{i,t} \tag{21}$$

where $\frac{B_{i,t}}{L_{i,t}}$ is the debt to assets ratio, $\frac{r_{i,t}B_{i,t}}{r_{i,t}B_{i,t} + CF_{i,t}}$ is the interest coverage measured as the interest expenses divided by the interest expenses plus cash flow and $\frac{B_{i,t} - F_{i,t}}{K_{i,t}}$ is the net debt defined as the debt minus financial assets divided by the capital stock. The c_j (where $j = 1,2\ldots6$) are parameters to be estimated and $\varepsilon_{i,t}^{\Lambda}$ represents a white noise disturbance.

If $c_5 = c_6 = 0$ this specification equals the specification of Whited (1992). Like in Whited's study, we thus concentrate on $\Lambda_{i,t}$ since $\lambda_{i,t}$ and $\gamma_{i,t}$ cannot be identified simultaneously. Notice that the larger $\Lambda_{i,t}$ is, the more debt-constrained at t the firm is.

The alternative approach to test for financial constraints, i.e. tests on the cost of debt ($r_{i,t}$), rely on the assumption of an elastic credit supply curve of financial institutions. Bond and Meghir (1994) and Estrada and Vallés (1995) specify the individual interest rate as a linear function of the (net) debt to capital ratio, i.e.

$$r_{i,t} = r_{f,t} + b\left(\frac{B_{i,t} - F_{i,t}}{K_{i,t}}\right) \tag{22}$$

where $r_{f,t}$ is a (riskless) interest rate; b is a parameter to be estimated and assumed to be positive. From an economic point of view this financial restriction is very different from (21). The entrepreneur of the model specified in the previous section that takes an investment decision and faces (22), accounts for the fact that the firms individual interest rate is influenced by the choice of the capital stock and debt level since the terms $\partial r_{i,t}/\partial K_{i,t}$ and $\partial r_{i,t}/\partial B_{i,t}$ appear in the model solution. The same entrepreneur, though, does not take into account cost effects or (future) debt restrictions by the specification (21).

In the empirical analyses presented in the next section we (unfortunately) had to assume $b = 0$. The reason is purely econometrical. Substituting (22) in the econometrical model entails that the parameter b appears in the denominator of $\beta_{i,t}^*$ and in the part $\partial r_{i,t}/\partial K_{i,t}$ in (20). As there is not much variation in $\beta_{i,t}^*$ convergence problems are encountered when estimating b. If another (individual interest) specification is taken in which, for instance, $\partial r_{i,t}/\partial K_{i,t} = 0$, the parameter b is not even identified at all. It has a tendency to go to infinity in order to minimize the criterium function. For these reasons $b = 0$ is maintained in further analyses.

3. Estimation results with Belgian panel data 1984–1992

The model (20) is estimated by the Generalized Method of Moments (GMM), see Hansen (1982), with a balanced sample that contains 436 firms. The GMM-procedure of TSP is used. For each model a system of annual equations with cross equation restrictions is estimated. The structural parameters are thus estimated directly. The convergence tolerance is 0.001. Corrections for conditional heteroscedasticity are made and the Bartlett kernel is used to ascertain the positive definiteness of the covariance matrix.

Before estimating the investment model (20) first differences are taken to eliminate the fixed effect f_i. The disturbance is hence a first order moving average and variables at least one period lagged are (theoretically) valid instruments. Different sets of instruments are used to test for the choice of instruments. For

Table 2
Tests on choice of instruments

Instruments	Real variables	D.f.	Real and financial Variables	D.f.
$t-1,t-2,t-3\ldots$	64.2 (0.33)	60	123.1 (0.48)	123
$t-2,t-3\ldots$	43.1 (0.43)	42	77.3 (0.76)	87
$t-1$	20.2 (0.16)	15	45.9* (0.07)	33
$t-2$	21.7** (0.04)	12	31.4 (0.26)	27

Real instrumental variables used are $Y_{i,t}/K_{i,t-1}$, $C_{i,t}/K_{i,t-1}$, $I_{i,t}/K_{i,t-1}$. Financial instrumental variables used are $CF_{i,t}/K_{i,t}$, $B_{i,t}/L_{i,t}$, $(B_{i,t}-F_{i,t})/K_{i,t}$. The figures are the Sargan statistics, calculated as the number of observations multiplied by the optimum criterium value. Df are the degrees of freedom. The figures in brackets are the P-values.
** Significant at the 5% level, * significant at the 10% level.

these tests the model (20) is estimated disregarding financial decisions, i.e. $\gamma_{i,t} = \lambda_{i,t} = E_t\{\lambda_{i,t+1}\} = \partial r_{i,t}/\partial K_{i,t} = \partial r_{i,t}/\partial B_{i,t} = 0$. Sargan-statistics of the model with different instrument sets are presented in Table 2.

The column 'Real variables' presents the Sargan or J-statistics where the variables $Y_{i,t}/K_{i,t-1}$, $C_{i,t}/K_{i,t-1}$, $I_{i,t}/K_{i,t-1}$ are used as instruments. In the first line these variables are lagged once, twice... etc. according to Arellano and Bond (1991). The equation of 1987 (in first differences) is thus instrumented with the variables of 1985, the equation of 1988 (in first differences) with instruments of 1985–1986,... and the equation of 1992 (in first differences) with variables of 1985–1990. In the second line variables lagged twice, lagged three periods... etc. are taken, whereas in the third and fourth line only variables lagged once and lagged twice are taken, respectively. In the column 'Real and financial variables' the financial variables $CF_{i,t}/K_{i,t}$, $B_{i,t}/L_{i,t}$, $(B_{i,t}-F_{i,t})/K_{i,t}$ are included additionally.

We first test the validity of instruments at $t-1$. The Sargan statistic of the model with instruments $t-1$, $t-2$, $t-3\ldots$ is neither rejected at the 30% level for the set with real variables nor for the set with both real and financial variables. A comparison of the parameter estimates — not presented here — shows that there are no significant differences between using the set $t-1$, $t-2$, $t-3\ldots$ and the set $t-2$, $t-3\ldots$. This allows us to continue with instruments that are lagged once.

As we want to know whether it is important to include instruments that are lagged more than one period, we test the set $t-1$, $t-2$, $t-3\ldots$ against the set with only $t-1$ (see line three). A comparison renders $64.2 - 20.2 = 44.0$ with

$60 - 15 = 45$ degrees of freedom, a statistic that is accepted at the 50% level. This implies that choosing the smallest set of instruments, i.e. $t - 1$, is not rejected against the alternative. A similar comparison for the sets with real and financial variables leads to the same conclusion. For this reason we will not use all available moment conditions but continue with instruments lagged once (see also Bond and Meghir, 1994).

Further tests (not shown here) with instrumental variables differenced once, do not render parameter estimates that are very different from the ones obtained here. For this reason we continue with the instrument set $t - 1$ of real (and financial) variables in levels.[2]

In order to verify the importance of financial factors in investment decisions by Belgian firms the neoclassical investment model is estimated under the assumption of perfect capital markets. The model (20) is thus estimated where $\Lambda_{i,t} = 0$. Real and financial variables are used — as in Table 2 — as instruments. If financial markets are perfect indeed and the model is correctly specified, the test for overidentifying restrictions must be accepted.

In the left part of Table 3 the GMM estimation results for the model without financial constraints are given. The parameter estimate for μ is highly significant and, as predicted by the theory, close to one. The parameter α is significant also, but in contradiction to the theory on convex adjustment costs, negative. The Sargan statistic of this model is rejected at the 6% level. This can indicate that the financial variables are important and correlate significantly with the error terms here.

In the right part of Table 3 the GMM results are given for the model where $\lambda_{\mathrm{i,t}}$ is specified as in (21). The six parameters c_j where $j = 1,2 \dots 6$ are estimated without causing any convergence or identification problems. These results show that the variable debt to liabilities is important since the parameters c_1 and c_2 are highly significant. The coverage and net debt to capital ratio seem less important. The mark-up μ is higher than in model 1 and the adjustment cost parameter is no longer significant.

The Sargan test shows further that the model is accepted at the 28% level. In comparison with the model without financial constraints, this second model with financial constraints thus performs better. Tests on the financial variables further show that the variable debt to liabilities is most important. The hypothesis H_{01}: $c_1 = c_2 = 0$ that is tested with a Wald test — with two degrees of freedom — has a test statistic 18.2. This hypothesis is thus rejected. Similar tests for the other two financial variables, shown in the bottom part of column four are accepted.

[2]An important aspect of the model with $t - 1$ instruments is that it is accepted at the 10% level when only real variables are used, while it is rejected when real and financial variables are used. This can indicate that the financial variables are correlated with the error term possibly due to the ommission of financial variables in the model here (see also the comments under (13)). This result was a.o. confirmed in Estrada and Vallés (1995), Table 1.

Table 3
GMM estimation results investment Euler equation

Parameters	Model 1: no financial constraints Total sample	Model 2: financial constraints Total sample
μ	1.04**	1.08**
[Mark-up]	(165.8)	(134.1)
α	−0.02**	0.004
[Adjustment costs]	(−2.0)	(0.2)
c_1		6.05
$\left[\frac{B_{i,t}}{L_{i,t}}\right]$		(3.8)
c_2		−9.34**
$\left[\frac{B_{i,t}}{L_{i,t}}\right]^2$		(−3.1)
c_3		0.08
$\left[\frac{r_{i,t}B_{i,t}}{r_{i,t}B_{i,t}+CF_{i,t}}\right]$		(0.6)
c_4		0.02
$\left[\left(\frac{r_{i,t}B_{i,t}}{r_{i,t}B_{i,t}+CF_{i,t}}\right)^2\right]$		(1.2)
c_5		−0.01
$\left[\frac{B_{i,t}-F_{i,t}}{K_{i,t}}\right]$		(−0.8)
c_6		−0.00
$\left[\left(\frac{B_{i,t}-F_{i,t}}{K_{i,t}}\right)^2\right]$		(−0.8)
Sargan statistic	45.7*	29.6
P-value	(0.05)	(0.28)
No. of firms	436	436
H_{01}: $c_1 = c_2 = 0$		18.2**
H_{02}: $c_3 = c_4 = 0$		1.5
H_{03}: $c_5 = c_6 = 0$		0.9

The total sample consists of 436 firms, i.e. 3924 observations. The figures in brackets are t-statistics. The parameter estimates for (six) time and (three) sector dummies are not presented. The degrees of freedom for the Sargan statistic of model 1 and 2 are 32 and 26, respectively. The number of degrees of freedom for the tests H_{01}–H_{03} is 2. Instruments used are $C_{i,t}/K_{i,t-1}$, $I_{i,t}/K_{i,t-1}$, $CF_{i,t}/K_{i,t}$, $(B_{i,t} - F_{i,t})/K_{i,t}$, all lagged once.
**Significant at the 5% level, *significant at the 10% level.

According to these findings, the level of debt to liabilities thus constrains firms more than their coverage or net debt to capital.

4. Coordination centers in Belgium

In this section some background information of coordination centers is given. Furthermore, descriptive statistics of CC firms are compared with those of non-CC firms.

4.1. Background

In 1982 coordination centers were created in Belgium with the objective to attract foreign firms and to boost investment. They are regional headquarters of multinational firms playing a role of intermediary between the mother company in the original country and her daughters in a particular region.[3] Their main activity is to coordinate and to support the activities of all firms that belong to the group.

Coordination centers provide non-financial and financial services. Non-financial services consist of advertising, the diffusion of information, research and development, computer assistance and centralizing accounting and administrative activities. Financial services consist of insuring, exchange rate heading and centralizing financial operations. In practice, the latter service implies handling and channelling financial flows within a group. It also permits to raise funds from external financial institutions to the benefit of the group.

Coordination centers render thus scale effects. The major advantages, though, are fiscal. One advantage is obtained by exonerating tax payments on interest earnings on bank deposits as well as dividends and interest charges. A second advantage results from the calculation of the taxable sum. The 'cost-plus' method is used, implying the calculation of the taxable sum as a percentage of the costs where the costs do not include depreciation allowances, wages and financial charges.

A coordination center can only work in favour of those firms that are members of the group. Each firm of a group is linked (directly or indirectly) by either a participation of at least 20% of the capital stock or 20% voting rights. To create a coordination center a firm(s) must satisfy certain requisites. The firm(s) must be (a member of) a multinational group, have a minimum amount of cash flow and revenues and a minimum number of workers.

In Table 4 the importance of the coordination centers in the Belgian economy is shown. In 1986 23% of all financial means in the manufacturing industry were obtained by means of coordination centers. This figure is 46% in 1994. The finance of investment by means of coordination centers has thus doubled in 9 years.[4]

[3] A region is defined here in a broad sense, for instance it can be Europe.

[4] More statistics on coordination centers can be found in Tychon (1995) and Banque Nationale de Belgique (1994).

Table 4
Investment in the manufacturing industry

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Financial means (in %) from CC	23	36	39	48	54	47	32	43	46

Source: Banque Nationale de Belgique (1994). Tableau 4.

Table 5
Averages of variables and ratios

	Unbalanced	Balanced			
	Total	Total	CC	Non-CC	Largest non-CC
Operating income ($Y_{i,t}$)	1495	1879	10 605	997	4732
Capital stock ($K_{i,t}$)	267	345	2115	167	1015
Persons employed ($Em_{i,t}$)	329	390	1887	239	998
Factors costs ($N_{i,t}W_t$)	1401	1781	10 029	948	4469
Debt ($B_{i,t}$)	278	331	2225	139	802
Short term debt ($B_{i,t}^s$)	81	84	403	52	216
Total liabilities ($L_{i,t}$)	1161	1332	8153	643	3208
Financial assets ($F_{i,t}$)	246	240	2048	57	296
Dividends ($D_{i,t}$)	22	20	115	10	50
Cash flow ($CF_{i,t}$)	137	148	883	74	416
Investment ($I_{i,t}$)	91	105	554	60	399
Debt charges ($r_{i,t}B_{i,t}$)	30	36	226	16	87
$Y_{i,t}/K_{i,t}$	5.60	5.45	5.01	5.97	4.66
$Em_{i,t}/K_{i,t}$	5.25	5.16	4.74	5.68	4.40
$B_{i,t}/K_{i,t}$	1.04	0.96	1.05	0.83	0.79
$F_{i,t}/K_{i,t}$	0.92	0.70	0.97	0.34	0.29
$CF_{i,t}/K_{i,t}$	0.51	0.43	0.42	0.44	0.41
$I_{i,t}/K_{i,t}$	0.34	0.30	0.26	0.36	0.39
$B_{i,t}/L_{i,t}$	0.24	0.25	0.27	0.22	0.25
$r_{i,t}B_{i,t}/(CF_{i,t} + r_{i,t}B_{i,t})$	0.18	0.20	0.20	0.18	0.17
No. of firms	946	436	40	396	40

All figures are in million Belgian Francs of 1980. The numbers are averages over the firms and the 9 years. CC-firms are those firms that are associated with a coordination center in 1992. The 'largest non-CC firms' are selected on the basis of the volume of the capital stock.

4.2. Descriptive statistics with the panel data

In Table 5 sample averages of some variables and ratios are presented. The column 'Total' under 'Unbalanced' contains statistics for the total unbalanced sample that consists of 946 firms. The column 'Total' under 'Balanced' contains the total balanced sample that consists of 436 firms. A comparison of these two columns shows that the selected balanced sample is rather representative.

The column 'CC firms' concerns those firms of the balanced sample that are associated with a coordination center in 1992. For our sample of 436 this concerns

40 firms, i.e. 9%. In the column ‘non-CC firms’ 396 firms are considered that are not members of a coordination center in 1992. Of those firms, 40 firms are selected that have the highest level of capital (results are quite similar when selecting on the basis of the number of workers employed). These 40 firms are considered in the column ‘Largest non-CC firms’. The CC firms are evidently large firms. By comparing these firms with the 40 largest non-CC firms we try to eliminate a selection bias.

The upper part of the table presents the variables in levels. The statistics of Table 5 show that the CC firms share of total investment is about 50%. This is confirmed here by the fact that the capital investment by 40 CC firms equals about the investment by the 396 non-CC firms. All other variables are also about 10 times larger for the CC than for the non-CC firms. The fact that CC firms are very large indeed is confirmed by their average capital stock that is more than twice the stock of the 40 largest firms (see the last column). This is also the case for all the other variables with two remarkable exceptions: the level of debt and the level of financial assets. The level of debt is almost 20 and three times larger than those of the non-CC and the 40 largest non-CC firms, respectively The financial assets are even 30 and seven times larger.

The lower part shows some ratios of interest. Both the ratio of debt to capital stock as well as the coverage of the CC firms turn out to be larger than those of the other two balanced groups. This may reflect that obtaining external finance is easier for CC-firms (see Sec. 2). This can however also be a consequence of their higher level of financial assets. As is clear from the $F_{i,t}/K_{i,t}$ ratio financial assets are almost 100% of the capital stock of CC firms, while they are only 33% for the non-CC firms. The ratio debt to financial assets is about 1, 2 and 3 for the CC, the non-CC and the 40 largest non-CC firms, respectively, while the debt to liabilities ratio is about 25% for all three groups. These facts reflect, once again, the more important role of financial investments for CC firms than for non-CC firms.

In comparison with firm studies of the US (see Whited, 1992), the UK (see Bond and Meghir, 1994) and Spain (see Estrada and Vallés, 1995) investment by Belgium firms is quite high. The investment to capital ratio for Belgium (1984–1992) is three times this ratio for the UK (1974–1986) and Spain (1984–1992) and 1.5 times this ratio in the US (1972–1986). At least for the UK and the US some caution holds, though, because much larger firms are considered.

To show the evolution over the sample period the variables used in the econometric analyses are presented in Fig. 1 and Fig. 2. The left graphs show the yearly sample means and the right graphs the yearly standard deviation. The effects of the recession at the beginning and at the end of the sample period are clearly visible. The investment capital ratio, for example, is hump-shaped.

Furthermore, like Table 5, these graphs point out the importance of the financial investment by firms. Despite the increase in the debt capital ratio during the sample period, the net debt to capital ratio —where net debt is debt minus financial assets — has sharply decreased. The net debt even becomes negative in the beginning of the 1990s.

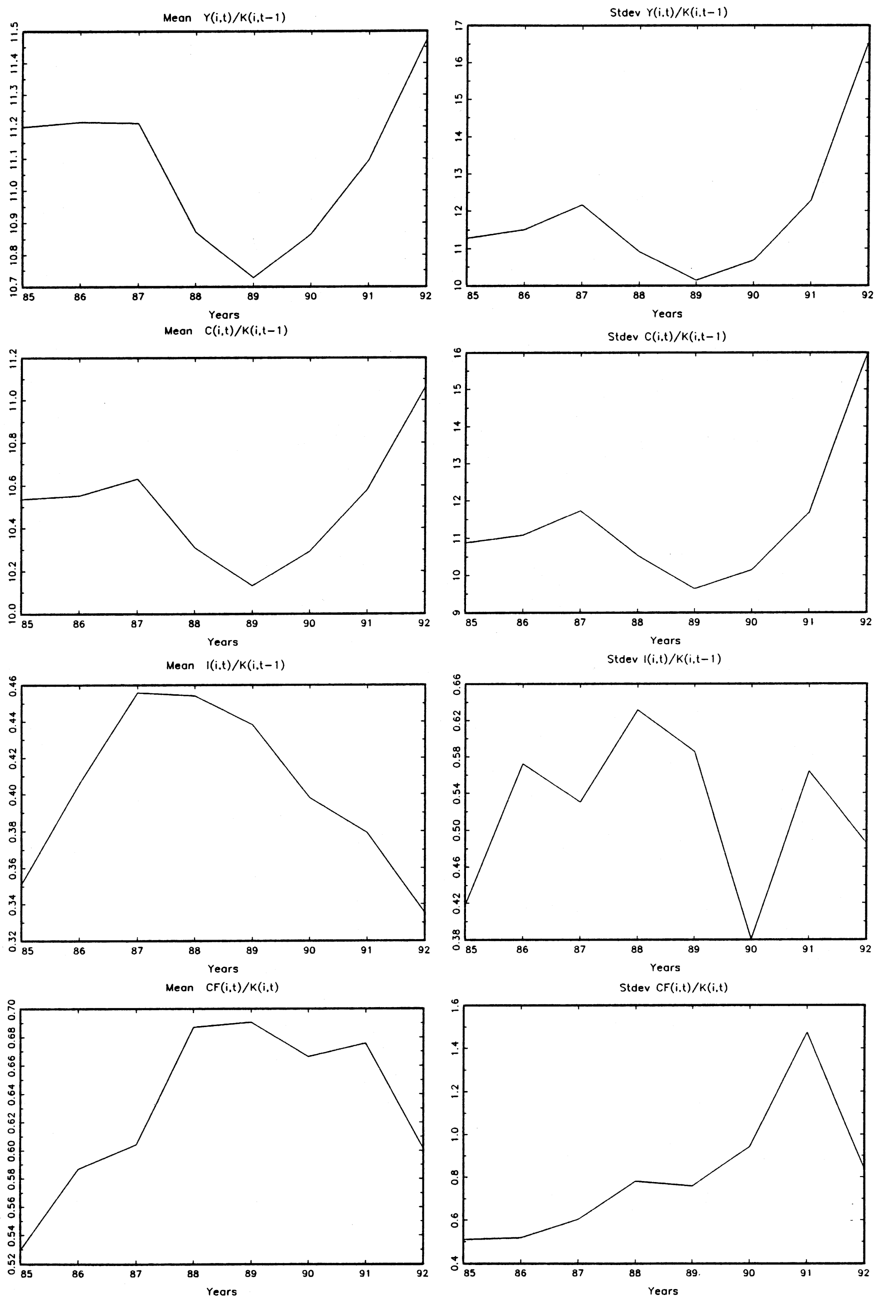

Fig. 1. Sample means and standard deviations.

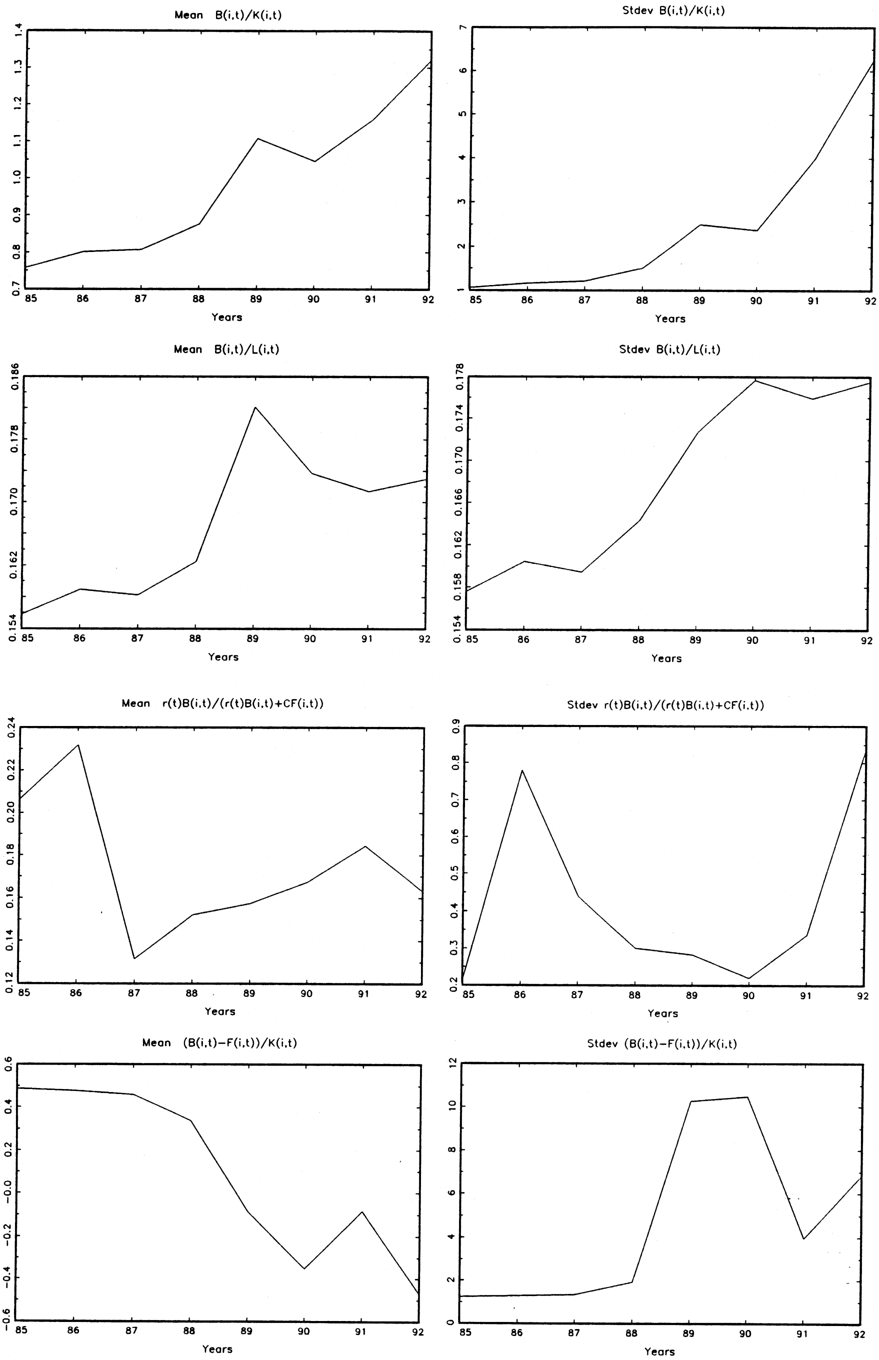

Fig. 2. Sample means and standard deviations.

Table 6
GMM estimation results investment Euler equation

Parameters	Model 1: no financial constraints		Model 2: financial constraints	
	Non-CC firms	CC-firms	Non-CC firms	CC-firms
μ	1.04**	1.08**	1.06**	1.09**
[Mark-up]	(190.7)	(39.7)	(110.2)	(38.1)
α	−0.02	−0.04	−0.01	−0.11
[Adjustment costs]	(−1.6)	(−1.0)	(−0.4)	(−1.8)
c_1			7.3**	1.93**
$\left[\frac{B_{i,t}}{L_{i,t}}\right]$			(4.6)	(2.6)
c_2			−12.4**	−1.5
$\left[\frac{B_{i,t}}{L_{i,t}}\right]^2$			(−3.4)	(−1.2)
c_3			0.09	0.08
$\left[\frac{r_{i,t}B_{i,t}}{r_{i,t}B_{i,t}+CF_{i,t}}\right]$			(0.5)	(0.7)
c_4			0.02	−0.01
$\left[\left(\frac{r_{i,t}B_{i,t}}{r_{i,t}B_{i,t}+CF_{i,t}}\right)^2\right]$			(1.6)	(−0.7)
c_5			0.01	−0.00
$\left[\frac{B_{i,t}-F_{i,t}}{K_{i,t}}\right]$			(0.7)	(−0.2)
c_6			0.001	0.00
$\left[\left(\frac{B_{i,t}-F_{i,t}}{K_{i,t}}\right)^2\right]$			(1.9)**	(0.1)
Sargan statistic	45.3*	38.8*	24.0	29.6
P-value	(0.06)	(0.05)	(0.57)	(0.28)
No. of firms	396	40	396	40
H_{01}: $c_1 = c_2 = 0$			28.6**	29.4**
H_{02}: $c_3 = c_4 = 0$			2.5	0.6
H_{03}: $c_5 = c_6 = 0$			4.0	2.7

See Table 3.

5. Estimation results for CC firms and non-CC firms

For the group of non-CC firms as well as for the group of CC firms Eq. (20) has been estimated. The estimation results are presented in Table 6, as they were presented in Table 3.

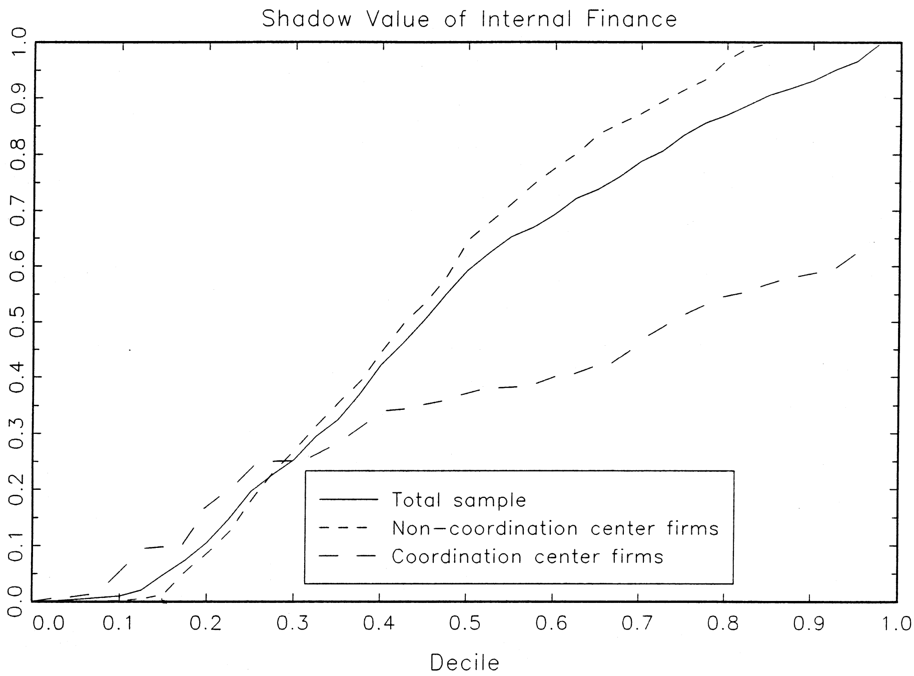

Fig. 3. Average $\Lambda_{i,t}$ according to GMM results.

The estimation results of model 1 are for both groups quite similar to the results of the whole sample (see Table 6): the parameter estimate for μ is highly significant and close to one and the parameter α is significant but negative. The Sargan statistic of the models are rejected at the 5% level. This indicates that the financial variables might be important.

For the model applied to the CC firms sample one remark is to be made here. This sample only consists of 40 observations. In order to reduce the dimension of the covariance matrix in TSP, i.e. in order to correct for heteroscedasticity, for each equation the same set of instruments (of 1985) are taken instead of lagging the instruments only once. For this reason the estimates here may be slightly more efficient and possibly biased (see Tauchen, 1986).

In the right part of Table 6 the GMM results are given for the model where $\Lambda_{i,t}$ is specified as in (21). Like the results for the whole sample, the conclusions for non-CC and CC firms leads also to the conclusions that the model is accepted at a relatively high significance level and that debt to liabilities is the most important financial variable. The markup-parameter for the non-CC firms is, though, 3% higher for the CC-firms. Also the value of the financial parameters differ considerably.

This is illustrated in Fig. 3. In this graph the fitted values of $\Lambda_{i,t}$ for the three samples are illustrated. This graph shows that the average $\Lambda_{i,t}$ is higher for the

Table 7
GMM estimation results investment Euler equation

Parameters	Model 3: financial constraints and BC-effect	
	Non-CC firms	CC-firms
c_7	0.40**	−0.17
$\left[s_t \frac{B_{i,t}}{L_{i,t}}\right]$	(2.31)	(−0.58)
Sargan statistic	20.2	28.9
P-value	(0.73)	(0.27)
No. of firms	396	40

See Table 3. As the results of the other parameter estimates do not differ much from those of model 2 in Table 6, they are not presented here.

non-CC firms than for the CC firms. Although the level of debt to liabilities is important in the investment decision, both for non-CC as well as for CC-firms, this ratio is higher for the former group of firms. According to these results CC firms are thus less financially constrained than non-CC firms and have a higher level of debt to liabilities in the CC firms sample than in the non-CC firms sample (see Table 5).

As a last experiment we investigate whether or not business cycle effects play a significant role. Like in Hubbard et al. (1995) we include in the specification (21) a business cycle effect $c_7 s_t \frac{B_{i,t}}{L_{i,t}}$ where c_7 is the parameter to be estimated, s_t a risk premium measured as the difference between the government bond yield and the prime lending rate, and $\frac{B_{i,t}}{L_{i,t}}$ the most significant financial factor that we have found in our previous analyses. We expect that c_7 is positive since an increase in the spread (risk premium) will have a positive effect on the financial restrictions and hence constrain the firm when taking investment decisions. The main results are presented in Table 7.

The results show that the business cycle effect is positive and strongly significant for the group of non-CC firms whereas it is not significant for the group of CC firms. This result indicates that investment by firms associated with a CC is less affected by economic fluctuations than firms that have to rely on public financial intermediaries to obtain external funds.

6. Summary and conclusions

In this paper a dynamic neoclassical model of investment is specified. This model is extended with financial constraints, estimated with Belgian panel data and further analyzed. The estimation results reject the standard neoclassical model whereas the model with financial constraints is accepted. This result is according to results obtained in other investment studies that test for the financial constraints.

Financial factors thus turn out to have a significant influence on Belgian investment decisions. But in Belgium coordination centers are said to be important as a financial channel. To test whether this is empirically corroborated, the sample is split into non-coordination and coordination center firms. According to the estimation results the balance sheet position is important for both groups, but the coordination center group turns out to be less financially constrained than the non-coordination center group. Furthermore, it turns out that the former group is less dependent on fluctuations in the risk premium over the business cycle. The coordination center group is thus apparently less dependent on business cycle effects although the statistics show that it has a higher debt to liabilities ratio than the non-coordination center group.

These results corroborate the expectations that the close relationship between coordination centers and member firms reduces informational problems, increases the level of debt to liabilities and hence reduces the dependence on internally generated funds. The group of firms that is related to coordination centers is (still) not fully independent of their debt position but coordination centers seem to have a significant effect on business investment indeed.

Acknowledgements

Research for this study was initiated when both authors worked at the Université Catholique de Louvain at Louvain-La-Neuve in Belgium. The Department of Economics of the Université Catholique de Louvain is gratefully acknowledged for financial support. For helpful comments we want to thank Ronald Anderson, Leo de Haan, Hugo Kruiniger, Elmer Sterken and Pierre Tychon. All errors are ours.

Appendix 1:

Data

In the first part of this data appendix the definition and construction of variables are described. In the second part the selection criteria are summarized.

Definition and construction of variables

The variables (below) associated with a number in brackets are from the balance sheet and the income statement of the National Belgian Bank. The number indicates the balance sheet or income statement item.

The individual variables

- Operating income ($Y_{i,t}$) is turnover (70) plus variations in stocks of finished goods, work and contracts in progress (71) plus fixed assets-own construction (72) plus other operating income (74).

- Cash flow ($CF_{i,t}$) is income (70/67 and 67/70) plus depreciation (630).
- Capital stock is the balance sheet value of capital stock. The real capital stock is calculated as $K_{i,t} \equiv \frac{K_{i,t}^{nom}}{P_{i,t}}$ where $K_{i,t}^{nom}$ is the balance sheet capital stock (22–27) and $P_{I,t}$ is the aggregate investment goods price.
- Gross investment ($I_{i,t}$) is calculated with the capital accumulation rule. For the real investment it holds that $I_{i,t} \equiv \frac{I_{i,t}^{nom}}{P_{I,t}}$ where $I_{i,t}^{nom} \equiv K_{i,t} - K_{i,t-1}\frac{P_{I,t}}{P_{I,t-1}}$ + capital depreciation (630).
- Employment ($Em_{i,t}$) is the number of persons employed (9090).
- Real factor costs ($N_{i,t}W_t$) are the remunerations, social security costs and raw materials and consumable purchases (60), services and other goods (61) and depreciation (630).
- Assets or liabilities ($L_{i,t}$) are the balance sheet totals (20–58).
- Gross debt ($B_{i,t}$) is the sum of the financial debts payable within 1 year (170–174) and the financial debts payable after 1 year (43).
- Financial assets ($F_{i,t}$) (28) comprise investment in affiliated enterprises, other enterprises linked by participating interests and other financial assets.
- Dividends ($D_{i,t}$) (694).

All nominal variables were deflated using the sectoral product prices index.

The sectoral variable

- Real investment price $P_{s,t} \equiv \frac{P_{I,t}}{P_{s,t}}$ where $P_{s,t}$ is the sectoral product price and $P_{I,t}$ the investment goods price. These (sectoral) prices are taken from the Belgian National Bank data base.

The aggregate variable

- Nominal interest rates ($r_{f,t}$) is the government bond yield from the International Financial Statistics (12461 ZF).

Selection criteria

The firms selected belong to the manufacturing industry. Three main sectors can be distinguished: ‘chemical’, ‘metal’ and ‘other manufacturing industry’. Only those firms are selected (i) that are public limited companies (corporates), (ii) with more than 20 employees, (iii) with a net value added of 20 000 BF, (iv) with total assets equal or larger than zero, (v) with equity equal or larger than zero, (vi) with a capital stock that does not increase with 500% within 1 year, (vii) with total liabilities that do not increase with 5000% within 1 year and (viii) that exist for 9 years.

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