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INTERACTION OF REAL AND FINANCIAL FLEXIBILITY: AN EMPIRICAL ANALYSIS

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ABSTRACT

This paper studies the interaction of real and financial flexibility and their effects on firm's investment and financing decisions. We use a system of interdependent dynamic partial adjustment models to capture the effects of flexibility and feedback from firm-specific adjustments towards the optimal levels of investment and debt. The empirical analysis is based on a large panel of multinational paper and pulp companies observed between 1992 and 2002. The results suggest that the decisions and flexibilities are related, interdependent and interacting, although financial adjustment costs are likely to dominate decision-making. Profitability is found to have strongest impact on the adjustment costs, which seem to be convex and non-constant over time and across firms.

Keywords: Investment, finance, flexibility, firms, paper and pulp, adjustment, dynamics

JEL Classification Numbers: C33, C51, E22, G30, G31, L73

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1. INTRODUCTION

This paper gets its motivation from capital structure theories that seem relatively sound, but are actually somewhat contradictory or ambiguous relative to the empirical evidence. Hence, the capital structure theories or indicators used to explain leverage or the financing process itself or their mixture is still at least partly misunderstood or at least unobserved. This is perhaps because many empirical studies of capital structure are static and use observed ratios as proxies for optimal leverage.[1] The assumption that observed ratios equal optimal ratios means that there is an instantaneous adjustment to the optimal without any costs. However, in the real world decisions are often dynamic and adjustments to firm-specific optimal levels are costly. In fact, these adjustment costs can control the firms' willingness to adjust, because they may not necessarily find it cost effective to adjust to the optimal frequently or fully even if they are aware of their state of in-optimality.

Indeed, dynamic models with the adjustment costs have improved the explanatory power and understanding of capital structure models and decisions. Jalivand and Harris (1984) find that firms' financing decisions are made to adjust partially to exogenously determined long-term financial targets, assuming that the deviations from the targets are characterized by the speed of adjustment, which is allowed to be firm and time-specific. Fischer, Heinkel and Zechner (1989) instead create a dynamic inventory-adjustment model in the presence of recapitalization costs, which uses an observed debt-ratio range (maximum and minimum values) as an empirical measure for capital structure. Banerjee, Heshmati and Wihlborg (1999) (also Kumbhakar, Hehsmati and Hjalmarsson (2002) and Heshmati (2002)) endogenize the adjustment factor, specify the targets in financing decisions, and introduce flexibility in to the speed of adjustment towards the target. Despite these developments, the dynamic capital structure literature still has a number of shortcomings. One important shortcoming is that investment and financing decisions are studied separately. Also, the flexibilities related to the decisions as well as the interaction of these flexibilities with each other and the underlying decisions are often overlooked.

The purpose of this study is to overcome these shortcomings of dynamic empirical capital structure models by using a system of interdependent dynamic partial adjusting models that allow us to capture the effects of separate but interdependent and simultaneous investment and financing decisions. This approach allows us to compare real and financial flexibilities measured through firm-specific adjustments to the optimal (i.e. their speed, costs and efficiency) and also the feedbacks related to these real and financial decisions. As a result, our approach should better acknowledge the impact of a firm's flexibility on substitutability and complementary effects of the investment and financing decisions that depend on both the flexibility available and the expected adjustment costs. Thus, better recognition of the effects of interacting flexibility is likely to reduce biases in the results, allow for non-partial inferences, and improve our understanding of the combined and interdependent corporate investment and financing decisions.

[1] For excellent discussion of capital structure and its problems in empirical measurement see e.g. Titman and Wessels (1988) and Rajan and Zingales (1995), and the references there.

Empirical results are based on a large sample of multinational paper and pulp producing companies observed between 1992 and 2002. These results suggests first of all that our system of dynamic partial adjusting models performs substantially better than the static models. Also, the speed of adjustment is found to be non-constant, which supports use of the flexible speed of adjustment function chosen. The results also show that the investment and financing decisions and the flexibilities related to them are interdependent and interacting due to the market imperfections found, which seem to invalidate the complete and perfect market hypothesis. Especially, the financial adjustment costs seem to dominate firms' decision-making. Perhaps not surprisingly, profitability is found to be the prominent key determinant factor of the adjustment costs, which seem to be otherwise convex and non-constant.

The rest of the paper is structured as follows. In Section 2, we introduce the readers to the theoretical background and motivations for the simultaneous determination of investment and financing decisions depending on the interacting real and financial flexibility. Section 3 introduces a system of interdependent dynamic partial adjusting models based on the theoretical hypothesis. The data and the set of variables used to capture the effects of the interaction between the real and financial flexibility are described in Section 4. The empirical results are then presented and discussed in Section 5. Finally, Section 6 concludes.

2. THEORIES OF REAL AND FINANCIAL FLEXIBILITY

The paper by Modigliani and Miller (1958) on the perfect and complete market hypothesis shows that if real and financial decisions are to have any effect on each other it is because of market frictions: tax and bankruptcy costs, agency costs or asymmetric information, whose effects are further amplified by the asset specificity[2].[3] Hence, if firms cannot instantaneously and costlessly undo their value creating decisions due to the existing market frictions, firms' investment and financing decisions become dependent on each other and the uncertain future expectations of the economic environment. Although this uncertainty about the future makes the systematic benefits of economic actions possible, it can also cause irrevocable costs, which are expected to motivate firms to maintain flexibility because of hedging, speculation, or transaction purposes.

Flexibility is a key mechanism to control investment dynamics, which arise because of the irreversibility of real and financial decisions and the uncertainty related to them. According to Dixit and Pindyck (1994), the irreversibility arises in capital investments

[2] Firm-specific assets are assets that are tailored to the firms to help them to create value by reducing their production costs, improve product or process quality, and differentiate their products from their competitors. These assets are usually intangible such as, R&D and brand, and thus, have lower collateral values. Asset specificity is thus closely related to real flexibility in which the assets with multiple uses and low redeployment costs tend to have higher market values.

[3] For the case of taxes see e.g. Modigliani and Miller (1963), Miller (1977), and De Angelo and Masulis (1980); for bankruptcy costs see e.g. Haugen and Senbet (1978) and Altman (1984); for agency cost see e.g. Jensen and Meckling (1976), Myers (1977), Easterbrook (1984), and Jensen (1986); and for asymmetric information see e.g. Akerlof (1970), Stiglitz and Weiss (1981), Myers (1984), and Myers and Majluf (1984). The theories of capital structure are well documented in e.g. Harris and Raviv (1991) and the references there.

due to firm-specificity, industry-specificity and lemon's premium[4]. Here irreversibility can be interpreted as an adjustment cost which on the one hand creates an incentive to learn through uncertain decisions because the waiting and adjustment for new information is not costless or independent of the past actions, but on the other hand, enhances the negative impact of uncertainty and its costs. The effect of uncertainty in decisions is generalized by Abel, Dixit, Eberly and Pindyck (1996), who point out that most decisions involve acquisition and exercise of several options simultaneously. These options reflect the firm's flexibility and their net effect is often ambiguous[5] due to the asymmetric and correlated effects of different underlying sources of uncertainty.

Firms' flexibility can be stored or invested in real and/or financial assets (hereon referred as real and financial flexibility). Financial flexibility may be beneficial for shareholders due to costly external financing, if it reduces the agency cost of debt related to under-investment and asset substitution problems or the cost of information asymmetry related to market transactions (e.g. discount or premium, signalling costs and/or information given to outsiders, and payments made to third parties). These benefits are, however, subject to agency cost of equity caused by management's willingness to risk-aversion and/or over-investment. A firm's real flexibility instead, on one hand, increases the liquidation and collateral values of its assets and thus, increases its debt capacity by lowering default risk and expected bankruptcy costs (Mauer and Triantis (1994)). On the other hand, it also decreases debt capacity by facilitating an increase in the portfolio of risky projects, which promotes risk-shifting and assets substitution, especially if limited liability is assumed (Mello and Parsons (1992)). Clearly, these flexibilities seem to overlap in their effects. Hence, Mauer and Triantis (1994) state that real and financial flexibilities are partial substitutes.[6]

Still, although firms may benefit from having flexibility when the opportunity cost of investing in flexibility is low relative to the cost of future market transactions, maintained flexibility itself is also costly. For instance, Kim, Mauer and Sherman (1998) and Opler, Pinkowitz, Stultz, and Williamson (1999) show that investment in liquid (or flexible) assets is costly because firm foregoes investment in less liquid but more productive fixed assets. In general, when the uncertainty over the decisions increases, the value of flexible (i.e. shorter-lived and more liquid) assets also increases, although at the expense of inflexible (i.e. more long-term and more irreversible) assets, such as new capital investments. The value of flexibility then arises even at the higher

[4] As lenders can more easily observe industry-wide risk and its effect within industry firms, it is the unobservable firm-specific risk that makes outsiders demand a premium or discount in market transactions. Still, investments that rely on private information and unique, firm-specific assets are the ones that provide excess returns and competitive advantage to the firm because they are hard to imitate or copy by the outsiders.

[5] Increase in uncertainty, on the one hand, raises the marginal valuation of an additional unit of capital and hence stimulates investments (see Hartman (1972) and Abel (1983)), but on the other hand it also increases opportunity cost. Increased opportunity cost tends to decrease the value of investments and thus, promote waiting (McDonald and Siegel (1986)).

[6] Quality (i.e. risk and return) of investments naturally affects firms' financial structures. Brander and Lewis (1986), Chevalier (1995), and Zingales (1998) show, however, that financial structure in turn can have impact on firms' performances on the real markets. According to Trigeorgis (1993), the interaction between the real and financial flexibility should be emphasized whenever it involves large or complex, uncertain and multi-staged investments or growth options that take time to build.

relative price, because the switching option (i.e. the opportunity to exchange assets to some other assets at low costs) attached to them is thought to be more valuable.

Although in the theory, firms' real and financial decisions and the related flexibilities are often assumed to be independent from each other, in the reality, they are more or less interdependent (See e.g. Mackay (1999) for empirical evidence). Indeed, firms' flexibility can be defined as the capacity to adjust the use of their real and financial resources under uncertainty to meet their evolving goals of long-term value creation (Donaldson (1969)). Financial flexibility can further be defined as firms' ability to reallocate cash flows between bond and stockholders through recapitalisations over time to better match the evolution of operational risk into their long-term value creation. Hence, changes in debt levels reflect adjustments that can provide information on firms' financial flexibility. As financial flexibility preserves mainly real flexibility the marginal adjustment cost of investing in financial flexibility increases as the cost difference between external and internal financing and the uncertainty over investments and their profitability decreases. Hence, firms that lack financial flexibility are in fact more likely to face binding financial constraints[7], which may also force them to adjust fixed investments relative to cash-flow shocks. Here real flexibility refers to firms' real resources that improve their ability to meet future operating and investment needs or simply growth options. Motivation for the real flexibility arises because the marginal adjustment costs of acquiring and installing capital rise as investments rise. In addition, firms cannot without additional cost store, delay or maintain new or in-progress investments, i.e. adjustment is costly. Now, if firms are allowed to operate many risky projects simultaneously, then we have to think of firms as choosing their optimal investment policy to alter their capital stocks and thus, the adjustments in capital stock are likely to provide information on their real flexibility.

To test the effects of flexibility, we next turn to the empirical modeling issues, where we study firms' adjustments to their firm-specific optimal investment and debt levels to provide information on their real and financial flexibilities and their interaction as well as effects on investment and financing decisions.

3. EMPIRICAL MODEL

The principal idea behind the capital structure theories is to find the optimal debt level by trading off the costs and benefits of the additional debt that can imply the interior optimal debt level for a firm[8]. However, most financial studies use one-period perfect

[7] In such cases, the marginal cost of external financing exceeds the opportunity cost of internally generated funds for a leveraged firm (see e.g. Fazzari, Hubbard and Petersen (1988) and Hubbard (1998)).

[8] The trade-off theory includes bankruptcy and agency cost models where the optimal debt ratios are found by trading off the tax advantage of interest rates on debt and other benefits of debt against the various costs of debt. These costs include increased probability and costs of bankruptcy that arise from the decrease in the market values of assets, the threat of payments made to the third parties, and agency costs of debt. On the other hand, asymmetric information models state that there is no optimal capital structure for a firm and that the use of a specific financing source is based on minimisation of the costs of asymmetric information. The empirical criticism of the trade-off theory is that new equity issues represent only a small fraction of firms' financing and that there is a negative relation between debt and profitability as predicted by the asymmetric information models. On the other hand, industry effects such as mean reversion of debt ratios and negative relation of debt and non-debt tax shields favour the trade-off theory contrary to asymmetric information models.

and complete market frameworks and thus study the financial decisions separately and independently of investments. As a result, these decisions become static and the effects of uncertainty and irreversibility on them as well as their interdependence with real decisions are often ignored. The real and financial decisions are in practise, however, made simultaneously under imperfect and incomplete information. This makes the decisions interacting and interdependent as well as dynamic, which emphasises the importance of flexibility and adjustment costs issues. Hence, many earlier financial models underestimate the complexity and variation over time in interdependent real and financial decisions that arise from the intended *a priori* policy and from the uncertainty over investment opportunities, financial structures and adjustment costs[9]. It is therefore important to examine firm-specific adjustment processes where firms are assumed to switch between constrained and unconstrained regimes depending upon the shifts in their adjustment needs and costs, and flexibility available.

Now, if the adjustment needs are defined as the difference between endogenous targets and current observed levels, we must separate policy from the actions taken. This is so because although firms may not be at their optimal in any point of time, they still may behave optimally, if adjustment costs and the flexibility that can be used to smooth the costs of the adjustments needed are taken into account. This smoothing behavior, i.e. the use of flexibility, is a result of firms wanting to minimize negative effects of uncertainty and their possible costs to a firm's value creation by reducing the adjustment costs related to costly changes in firm's expectations of future investment opportunities and profitability. Thus, this behavior aims at finding an optimal combination of investment and debt levels that maximizes the firm's value in the long-term. In this process, the individual decision-specific effects are of course most important. However, because firms' flexibility in reality is multidimensional and interdependent and thus, somewhat invisible in the financial statements, especially if firms are allowed to operate many risky projects simultaneously, an empirical analysis should instead think of firms as choosing their optimal policy to alter their investment and debt levels to capture the effects of flexibility.

To take the above arguments into account, we use dynamic partial adjusting models that allow us not only to capture the determinants of the optimal levels of investments and debt but also the adjustments towards their optimal or target levels. These endogenous firm-specific adjustments contain information about the firm's flexibility and its indicators: speed, cost and efficiency of adjustment in response to external shocks and changes in market conditions. However, separate dynamic partial adjusting models for real and financial decisions are not entirely satisfactory because the single equation technique does not permit analysis of simultaneity. To avoid incorrect inferences of causalities or feedbacks among the policy choices, i.e. in our case between interdependent and interacting real and financial decisions, we use the system of simultaneous equations to identify the effects of the interacting decisions by controlling the unobservable effects. Finally, as firm-specific effects are often shown to be most crucial for a firm's success, we prefer to use panel data to control the heterogeneity over firms and over time.

[9] Jalivand and Harris (1984) are among the first to recognise the importance of a dynamic approach with adjustment costs in finance. Fischer, Heinkel and Zechner (1989) instead create dynamic inventory-adjustment model with recapitalisation costs. Banerjee, Heshmati and Wihlborg (1999) endogenize the flexible adjustment factor and the targets in financial decisions.

Let's now take a closer look at our model specifications, where we let optimal levels of the key variables, investment and financing decisions be determined by the following formulas:

$$(1)\qquad \begin{aligned} R_{it}^{*} &= f(\hat{F}_{it}, X_{it}^{R}, X_{t}^{R}, X_{i}^{R}) \\ F_{it}^{*} &= g(\hat{R}_{it}, X_{it}^{F}, X_{t}^{F}, X_{i}^{F}) \end{aligned}$$

where R_{it}^{*} and F_{it}^{*} denote optimal real and financial decisions of firm *i* at time *t*, $\hat{R}_{it}$ and $\hat{F}_{it}$ are their predicted counterparts or feedbacks from one decision to another, X_{it}, X_{t} and X_{i} are vectors of firm- and time-variant, time-variant and firm-variant explanatory variables, and *f* and *g* indicates functional forms. The latter two X variables are often replaced by firm and time dummies. The variables may partially overlap across the two equations. Allowing changes in the observed levels to have affect the changes in the optimal levels here captures the dynamics because the changes in observed levels cause the optimal to shift. This dynamics of the changing optimal has been neglected in many time series models, for example. Still under ideal conditions, the observed levels should equal the optimal, i.e. $R_{it} = R_{it}^{*}$ and $F_{it} = F_{it}^{*}$ as in static models. In a dynamic setting, this means that $R_{it} - R_{i,t-1} = R_{it}^{*} - R_{i,t-1}$ and $F_{it} - F_{i,t-1} = F_{it}^{*} - F_{i,t-1}$.

However, if the adjustment is found to be costly (mainly because of market imperfections), then firms may find it optimal to adjust only partially:

$$(2)\qquad \begin{aligned} R_{it} - R_{i,t-1} &= \delta_{it}^{R}(R_{it}^{*} - R_{i,t-1}) \\ F_{it} - F_{i,t-1} &= \delta_{it}^{F}(F_{it}^{*} - F_{i,t-1}) \end{aligned}$$

where the δ_{it}^{R} and δ_{it}^{F} are adjustment parameters that measure the speed of adjustment or the rate of convergence of observed to optimal levels of investment and debt. This means that although firms may not be at their optimal at any point of time, they may still behave optimally if adjustment costs are taken into account. Thus, the equation (2) also represents an equilibrium relation, where adjustment costs are given. For example, if $\delta_{it}^{R} = 1$ or $\delta_{it}^{F} = 1$, the adjustment is made fully within one period and the firm is in its optimum. If $\delta_{it}^{R} < 1$ or $\delta_{it}^{F} < 1$, the adjustment falls short, and respectively, if $\delta_{it}^{R} > 1$ or $\delta_{it}^{F} > 1$, there is an over-adjustment. However, if instead $\delta_{it}^{R} < 0$ or $\delta_{it}^{F} < 0$, there is no external adjustment and firms adjust internally using flexibility, for example. These periodical adjustments also mean that changes in factors affecting the optimal beyond time *t* are unanticipated and therefore, current and past optimal values can be used to predict the future behaviour of the firm.

Interestingly, the adjustment parameter is allowed to be flexible, which is justified because the costs of adjustment do not have to be convex or constant as is often assumed in many dynamic models. This is true especially if fixed costs or other non-quadratic effects are allowed to exist in the adjustment (Abel and Eberly (1994)). It is also important because of the assumed heterogeneity in the cost of adjustment among firms, industries and over time. Hence, the adjustment parameter is a function of:

$$\text{(3)} \qquad \begin{aligned} \delta_{it}^{R} &= k(Z_{it}^{R}, Z_{t}^{R}, Z_{i}^{R}) \\ \delta_{it}^{F} &= l(Z_{it}^{F}, Z_{t}^{F}, Z_{i}^{F}) \end{aligned}$$

where Z_{it}, Z_t and Z_i are vectors of firm- and time-specific, time-specific, and firm-specific determinants of the speed of adjustment. The determinants of the adjustment parameter measure adjustment costs that characterize the costs of shifting from one level to another rather than the actual cost associated with specific levels of investments or debt. The positive sign of an adjustment cost parameter indicates that the variable increases the speed of adjustment and *vice versa*. In the presence of adjustment costs, the ratios (R_{it}^{*} / R_{it}) and (F_{it}^{*} / F_{it}) can be used to measure the degree of optimality or efficiency in investment and debt levels without any future implications. As the speed of adjustment carries information on the speed, costs and efficiency of adjustment, it can also be used as a proxy for firms' flexibility.

To avoid the misspecification errors caused by aggregation effects, the absence of adjustment costs and the employment of non-dynamic affects, the equation (2) can be written as follows:

$$\text{(4)} \qquad \begin{aligned} R_{it} &= (1-\delta_{it}^{R})R_{i,t-1} + \delta_{it}^{R} R_{it}^{*} + u_{it}^{R} \\ F_{it} &= (1-\delta_{it}^{F})F_{i,t-1} + \delta_{it}^{F} F_{it}^{*} + u_{it}^{F} \end{aligned}$$

where $R_{it}^{*}, F_{it}^{*}, \delta_{it}^{R}$ and δ_{it}^{F} can take following general functional relations:

$$\text{(5)} \qquad \begin{aligned} R_{it}^{*} &= \alpha_0 + \alpha_F \hat{F}_{it} + \sum_{j=1}^{J} \alpha_j X_{jit}^{R} + \sum_{t=1}^{T} \alpha_t X_{t}^{R} + \sum_{n=1}^{N} \alpha_i X_{i}^{R} \\ F_{it}^{*} &= \beta_0 + \beta_R \hat{R}_{it} + \sum_{j=1}^{J} \beta_j X_{jit}^{F} + \sum_{t=1}^{T} \beta_t X_{t}^{F} + \sum_{n=1}^{N} \beta_i X_{i}^{F} \end{aligned}$$

and

$$\text{(6)} \qquad \begin{aligned} \delta_{it}^{R} &= \zeta_0 + \sum_{j=1}^{J} \zeta_j Z_{jit}^{R} + \sum_{t=1}^{T} \zeta_t Z_{t}^{R} + \sum_{n=1}^{N} \zeta_i Z_{i}^{R} \\ \delta_{it}^{F} &= \xi_0 + \sum_{j=1}^{J} \xi_j Z_{jit}^{F} + \sum_{t=1}^{T} \xi_t Z_{t}^{F} + \sum_{n=1}^{N} \xi_i Z_{i}^{F} \end{aligned}$$

The u_{it}^{R} and u_{it}^{F} are the random error terms specified as a two-way error component structure as follows:

$$\text{(7)} \qquad \begin{aligned} u_{it}^{R} &= \mu_{i}^{R} + \lambda_{t}^{R} + v_{it}^{R} \\ u_{it}^{F} &= \mu_{i}^{F} + \lambda_{t}^{F} + v_{it}^{F} \end{aligned}$$

where μ and λ are unobservable firm-specific and time-specific effects, and v_{it}^{R} and v_{it}^{F} are random error terms which are assumed to be independently and identically, normally distributed, with means *0* and variances σ_{v}^{2R} and σ_{v}^{2F}. The μ and λ effects can be treated as fixed or random effects. In the latter case, the effects are assumed to be distributed with a mean of *0* and variances $\sigma_{\mu}^{2R}, \sigma_{\mu}^{2F}, \sigma_{\lambda}^{2R}$ and σ_{λ}^{2F}. These components are assumed to be independent of each other and of the explanatory variables. The parameter estimates in the dynamic models reflect short-run elasticities of real and financial variables or flexibility components with respect to changes in the explanatory variables. The long-run counterparts are obtained by multiplying the short-run elasticities with the adjustment parameters.

Now, one possible problem with this approach is that the explanatory variables are determined jointly with the dependent variables, that is they are not exogenously given. To solve the problem, we let firms have two separate, but interacting decisions, say one for investments and the other for financing, each defined according to equation (4). These equations determine the optimal levels for the dependent variables. However, as the decisions are assumed to be interacting and made simultaneously, we have to allow feedback to enter in the equations as shown in equation (5). The predicted values for debt ($\hat{F}$) and investment ($\hat{R}$) are based on the static models with similar specifications as those in the dynamic model but based on a single equation technique. After doing this and the other procedures above, we are finally able to analyse empirically the effects of real and financial flexibility on each other and on the interacting investment and financing decisions.

4. DATA AND VARIABLES

Before a discussion of the variables, we will briefly describe the data that we have used. We have used the DATASTREAM – company account data on the paper industry firms that have total annual sales exceeding USD 200M observed during 1992 to 2002. Our empirical results are based on an unbalanced panel of 87 firms. We have imputed a number of missing unit observations using lag, lead, or mean values by firm. After making these adjustments to the data, we received a sample size of 629 observations to be used in the estimation. These observations are observed consecutively, but we allow for exit and entry of the firm. Our data thus consists mainly of large firms in mature but cyclical industry that are expected to be capital intensive. In addition, investments are expected to be mostly fixed and long-lasting. Firms' financial statuses are expected to be quite solid. The data and the variables used are described more in detail in Appendix 1. The descriptive statistics are summarized in Table 1.

The variables included as the explanatory variables are assumed to provide flexibility for the decision variables and thus, are here also called flexibility components. As the flexibility components are assumed to be partial substitutes or complements for the decision variables, we observe the entire set of variables at the same period. Following the standard practise in investment and finance literature, we have also divided each variable by the beginning of the period replacement value of fixed assets or book value of total assets depending on the decisions in question. This transformation from the levels to ratios makes it possible to compare investment and financing ratios over time and across firms and thus, is a standard way to gain trend-stationary series. The transformation has also the advantage of minimizing the heteroscedasticity in the data by normalizing the variables by size.

The data in Table 1 shows that firms' investments (*I*) in net fixed assets totalled around 10% (28%) of the firms' net fixed assets (*K*). Real working capital (*RWC*) seems to take an even large share of firms' net fixed asset with its mean 29% (51%). Intangible assets (*IT*) have similar share as the fixed investments of the fixed assets, i.e. mean 10% (21%). Sales of firms under study are growing (*G*) on average 10% (31%). The cash flow (*CF*) to fixed assets, which is to proxy effect of internal financing, has a mean of 24% (24%). The numbers in the parentheses are standard deviations. All these variables of interest seem to have approximately equal or greater variance compared with the fixed investments, which could imply that they promote real flexibility.

Long-term debt (*D*) makes only 26% (32%) of the total assets (*A*). Mean financial working capital (*FWC*) is -4% (14%). Tangible assets (*K*) make a large share of total assets, their mean value is 57% (23%) and thus they provide good collateral for the lenders. As the non-debt tax shields (*NDTS*) can measure different things depending on its denominator, we have used two measures for it. The first measure, *NTDS/A* measured as depreciation to total assets, is a proxy for the amount of information asymmetry with mean 5% (5%) and the second measure, *NTDS/CF* measured as depreciation to cash-flows, is a proxy for tax effects and has a mean 50% (46%) of the cash flows. Again the numbers in parentheses are standard deviations.

In accounting for the negative effects of multicollinearity, we have taken a look at the correlations between the variables presented in Appendix 2. A positive correlation between the dependent variables and explanatory variables is desirable, but not a correlation among the explanatory variables, which causes difficulties in separating their effects from each other. Low correlation coefficients indicate an absence of serious multicollinearity. A few exceptions, indicating only a noticeable (greater than ±0.50) positive correlation is observed between investment and fixed assets (0.63, i.e. investment in fixed assets is naturally correlated with the fixed assets), growth and debt (0.57, i.e. growing companies are able to borrow more), profitability and share of internal financing (0.88, i.e. obviously one expects such high correlation) and size and variance of cash-flows (0.92, i.e. changes in assets and cash flows follow each other).

Next we will discuss the set of explanatory variables and their inter-relations. The variables are grouped by the set of determinants of the real flexibility, financial flexibility, and the speeds of adjustment in the two decision equations.

4.1. Determinants of real flexibility

The real or investment decision (*R*) model given the conditions discussed above is specified as the following:

$$(8)\quad R_{it}^{*} = \frac{I_{it}^{*}}{K_{it-1}} = \alpha_0 + \alpha_D \frac{\hat{D}_{it}}{A_{it-1}} + \alpha_{RWC} \frac{RWC_{it}}{K_{it-1}} + \alpha_L \frac{L_{it}}{K_{it-1}} + \alpha_{IT} \frac{IT_{it}}{K_{it-1}} + \alpha_G G_{it} + \alpha_{CF} \frac{CF_{it}}{K_{it-1}} + \alpha_{LVCF} LVCF + \sum \alpha_S D_S$$

The real flexibility is captured through the adjustments of investment levels towards their optimal levels. Optimal investment is allowed to vary across firms and over time and be a function of observable determining variables. The variable *I* denotes investments in fixed assets and it is measured as the difference between the current and previous year's net fixed assets. The *K* variable represents the replacement value of long-term capital stock and it is proxied with net fixed assets, i.e. fixed assets less depreciation. However, before making the adjustment to the investments, a firm may find it cost effective to use flexibility components related to its investments, such as real working capital (RWC), labour (L) and intangibles (IT) assets.

By reducing the investments in these flexibility components that are competing with the fixed investments over firms' scarce resources, firms can free resources to enable their new fixed investments. In addition, growth (G) in sales can describe investment demand and especially, its cyclical nature. Furthermore, as the ability to finance investments internally (i.e. partial proxy for investment supply) is often found to be one of the most important variables describing the investment behaviour of firms, we also include the cash flow (CF) as an explanatory variable. As the uncertainty can have negative effects on investment, we measure business risk and its effect on investments through the variance of cash flow measured in logarithm (LVCF).

Working capital defined as current assets less current liabilities is an important use of funds and therefore competes with fixed investment for firms' limited financial resources. Thus, it should also be negatively correlated with them. In general, if changes in the level of fixed investments are costly and firms cannot without costs raise external financing to counteract cash-flow fluctuations, then firms, especially the financially constrained, can use working capital to absorb negative shocks (Fazzari and Petersen (1993)). However, only part of the working capital can be used as a proxy for a short-term real flexibility of a firm. To separate real flexibility from the rest of the working capital, or the financial flexibility, we let *real working capital* (*RWC*) equal working capital less cash and marketable securities and short-term debt due less than one year. This leaves inventories, account receivables and non-debt account payables to be studied as real flexibility. This separation procedure recognises that cash and marketable securities and short-term debt are financial variables rather than operating decision variables. For example, inventories that are an important part of real working capital can be used to level out pro-cyclically the effects of cash-flow shocks[10]. Real working capital is expected to be negatively related to changes in investment levels.

Intangible asset (*IT*) is measured as a firm's total intangible assets. The role of intangible assets is to capture the effects of asset specificity or uniqueness. The reason is that investments in intangibles cannot be readily redeployed. Firm-specificity in assets increases with investments in intangible assets and thus tends not only to lower a firm's leverage but also eventually its fixed investments. Hence, to enable current fixed investments or to improve their quality on external financing markets, a firm can reduce its investment in intangible assets, i.e. activated[11] R&D and advertising costs. If intangible assets have high adjustments cost, we would expect only severe and long-lasting cash-flow shocks to affect the level of intangible investments. Still, to be able to fully extract values from the investments in intangible assets, one must also combine them with investment in fixed assets and hence, there may be a positive relation between the two as well. Depending on the role of intangible assets in firms' value creation, the significance and sign of intangibles to firms' investments is expected to vary.

[10] Fazzari and Petersen (1993) find that working capital with and without inventories has significant negative effect on fixed investments, providing evidence that all components of working capital contribute to the adjustment of fixed investments.

[11] If the R&D or advertising costs are expensed, they are more like non-debt tax shields.

The effect of *labour* (L) on investments is measured through the number of employees. With the same logic as in the case of intangible assets, labour can be used to adjust price shocks in the long-term. If labour can adjust to price shocks, then price fluctuations lead a firm to change its labour-capital ratio. This causes the marginal revenue of capital products to change by more than the movements in prices. The labour to fixed assets ratio also indicates changes in technical substitution or automation rate. This measure is usually found to be positive for a growing firm.

Growth (G) measured as a perpetual change in sales is a partial proxy for investment demand. Although growing firms are expected to have more flexibility in their choices of future investments, the costs associated with information asymmetry and agency relations are also higher. Therefore, highly leveraged growing firms may eventually be forced to reduce their investments. On the other hand, expected future growth may also make a firm invest more because otherwise it may signal lower future profitability, which may prove to be even more costly to the firm.

Cash-flow (CF) to fixed capital measures the financial flexibility or availability of internal funds relative to fixed capital. The larger the cash flows, the more they can support a firm's investment plans. In many studies this measure is found to be the most important variable explaining investment behaviour. The measure is expected to be positively related to investments because firms can reduce their dependence on costly external financing despite information asymmetry, and because management can be more prone to overinvest for its own benefit.

Variance of cash-flow ($LVCF$) measured in logarithm is a proxy for business risk and it affects both investment and debt levels. Minton and Schrand (1999) find that the volatility of cash flow is associated with lower investments due to higher frequency of cash-flow shortfalls and with higher costs of accessing external financing. It may have affect investments because financially constrained firms in particular may find it necessary to adjust fixed investments relative to cash-flow shocks. On the other hand, the uncertainty can also increase investments if the higher tail in the payoffs distribution increases more than the lower tail. However, in general the effect of uncertainty over investments is often found to be ambiguous.

The variable D represents the vector of *industrial sector* and time-specific dummies that are used to capture unobservable sector and technology effects.

4.2. Determinants of financial flexibility

The financial decision (F) model given the conditions discussed previously is specified in the following way:

$$F_{it}^{*} = \frac{D_{it}^{*}}{A_{it-1}} = \beta_0 + \beta_I \frac{\hat{I}_{it}}{K_{it-1}} + \beta_{FWC} \frac{FWC_{it}}{A_{it-1}} + \beta_K \frac{K_{it}}{A_{it-1}} + \beta_{NDTS1} \frac{NDTS_{it}}{A_{it-1}} + \beta_{NDTS2} \frac{NDTS_{it}}{CF_{it-1}} + \beta_{LVCF} LVCF + \sum \beta_S D_S \quad (9)$$

We use the adjustment of the firm's debt level as a proxy for financial flexibility. Optimal leverage is measured as the total book value of long-term debt (D) divided by total assets (A). The debt is allowed to vary across firms and over time and to be a function of determining variables. One of the main factors subject to intense debate in empirical capital structure studies is a measure of leverage, that is whether to use the market or book value of debt as the correct measure for leverage. In practise, both measures are often used and compared[12]. In this paper, we choose to use book values because they are more often used in making decisions on the variables of interest here. Since we are here interested in the components of financial flexibility that have affect on financing decisions[13], we include financial working capital (FWC), tangible assets (K), non-debt tax shields (NDTS) and variance of cash-flows (LVCF) to the set of explanatory variables.

Firms are expected to adjust deficit between their operating earnings and investment by acquiring external financing or using short-term financial assets. In regards to the discussion on real flexibility, Fazzari and Petersen (1993) state that apart from being an important use of funds, working capital is also a source of funds because it provides liquidity for adjusting fixed investments relative to fluctuations in cash flow without the need for costly external financing. Hence, we believe firms react to short-term deficits by adjusting the slack in their working capital. However, as we are more interested in short-term financial flexibility that can be thought of as relaxing firms' short-run financing constraints by reducing adjustment costs, we use *financial working capital* (*FWC*), i.e. cash and marketable securities less short-term debt, as a proxy for it. Financial working capital thus measures net position in liquid assets by relating liquid assets to short-term debt. Therefore, it also gives a better picture of a firm's short-term financial flexibility than pure liquid assets that is often used as a corresponding measure in literature. Nevertheless, we believe that the literature on liquid assets[14] can still provide empirical predictions or can be used as a reference for financial flexibility, although not without caution.

Tangible assets (*K*) measured as net fixed assets restrict the risk of asset substitution and such assets have more value in liquidation and thus improve debt capacity by offering one form of collateral to possible lenders. Collateralised lending where lenders do not need to be compensated for information costs behaves much like "risk-free debt". Change in the amount of risk-free debt should not change the firm's risk status and thus should not have impact on the financing costs. Here we expect the results to be similar to the result from all corporate finance theories about fixed assets: the greater the share

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[12] Those who favour the use of the *book value* measure present two strong arguments for their choice. First, the main cost of borrowing is the expected cost of financial distress in the event of bankruptcy. Financial distress raises the cost of capital and thus, affects the optimal leverage. In such situations, the value of the distressed firm is closer to its book value because at bankruptcy the debt-holders claim is based on the book value of debt. In addition, changes in the market value of debt issued do not affect the interest tax shields. Second, managers think in terms of book ratios rather than market values. Of course, book values are also more easily accessible, more accurately recorded, and not subject to market volatility. On the other hand, those favouring *market values* over book value argue that the market value ultimately determines the real value of a firm. They also suggest that a firm could have negative book value for equity while simultaneously having positive market value. This is possible because a negative book value reflects previous losses while a positive market value denotes the expected future cash flows of the firm.

[13] Harris and Raviv (1991) identified the following attributes to affect the choice of capital structure: leverage increases with fixed assets, non-debt tax shields, growth opportunities and size; and decreases with volatility of cash flows, probability of bankruptcy, profitability and uniqueness of assets.

[14] See e.g. Kim et al (1998) and Opler et al (1999)

of the total asset composed of tangible assets, the more collateral value a firm has and the greater leverage with lower financial costs the firm is able to maintain. However, the more specialized the fixed assets are, the higher the costs a firm faces when adjusting its capital stock.

We measure *non-debt tax shields* (*NDTS*) as the total depreciation and provisions. Also, R&D and advertising expenses are often used as a proxy for non-debt tax shields[15], but we ignored them due to a lack of data. To reduce taxes, the firm may use non-debt tax shields as a substitute for the tax shields provided by the interest rates. However, the non-debt tax shields may also be related to collateral values and thus, to asset specificity or uniqueness depending on the denominator. Therefore, we use two measures for the non-debt tax shields that we expect to proxy different effects. As depreciation and provisions are more for the smoothing of taxes rather than for financing purposes as such, the depreciation to the firm's cash flow that is expected to measure the "real" effects of the non-debt tax shields denoted as *NDTS/CF*. The other measure for non-debt tax shields is a depreciation to total asset which reflects asset specificity or re-deployability of assets, labelled *NDTS/A*. As *NDTS/A* measures the reverse depreciation time, the smaller its mean value the greater is the information asymmetry linked to the assets. Hence, the more specialized the assets are, the less their market value in liquidation, which again reduces the debt capacity. However, specialised assets can also increase company value as described earlier and therefore, the sign can be the opposite as well. Yet we expect both measures of the non-debt tax shields to be negatively correlated with firms' debt capacity.

With regards to the effects of *volatility of cash flow* (*LVCF*) on investments, Minton and Schrand (1999) state that the volatility of cash flow is also associated with higher costs of accessing external financing. The increase in variance of cash flows increases the expected bankruptcy costs due to the increased probability of bankruptcy and thus eventually results in a higher financial costs and lower level of leverage. However, under limited liability, shareholders may still benefit from increases in the volatility of cash flows because of better abilities for asset substitution or over-investment due to the asymmetric effect in payoffs. In addition, volatility of cash-flows decreases the value of interest rate tax shields and non-debt tax shields (e.g. depreciation) because it is more likely that they are not beneficial to a firm.

Vector *D* represents again the vector of the industrial sector- and time-specific dummies that are used to capture unobservable sector and exogenous technology effects.

4.3. Determinants of speeds of adjustments

Empirically, the speed of adjustment can be estimated in terms of the observable determinant variables affecting the speed of adjustment in real and financial decisions and is given as follows:

[15] Bradley, Jarrell and Kim (1984) find negative relations between debt and R&D because of agency costs and non-debt tax shields. These findings are also qualitatively supported by Long and Malitz (1985) and Titman & Wessel (1988).

$$(10)\qquad \begin{aligned}\delta_{it}^{R} &= \zeta_0 + \zeta_{DIST} DIST_{it}^{R} + \zeta_{SIZE} SIZE_{it} + \zeta_{CF}\frac{CF_{it}}{A_{it}} + \zeta_Q Q_{it}\\ \delta_{it}^{F} &= \xi_0 + \xi_{DIST} DIST_{it}^{F} + \xi_{SIZE} SIZE_{it} + \xi_{CF}\frac{CF_{it}}{A_{it}} + \xi_Q Q_{it}\end{aligned}$$

The speeds of adjustments towards the optimal level of investments and debt are expected to depend on the variables affecting the optimal levels. They are allowed to vary across firms and over time and be a function of determinant variables. Industry and time-specific effects may also differ across optimal and adjustment rate equations. With the exception of a distance variable, we have included the same four variables measuring cost effects into both the speed of adjustment functions to allow comparison between real and financial flexibility. The included cost variables are distance from the optimal (DIST), firm size (SIZE), profitability (CF), and growth opportunities (Q).

In general, the adjustment costs are expected to depend on the distance from the optimal and the speed chosen to adjust towards it. The farther a firm is from its optimal and the faster it chooses to adjust towards the optimal, then the more costly the adjustment is expected to become. Adjustment costs thus force a firm to think about the future, as too fast accumulation of capital is costly, and too slow, on the other hand, results in lost profits. Therefore, they also indicate the irreversibility of decisions.

The *distance from the optimal* (*DIST*) measured as distance between optimal and observed levels in both investment and debt levels can be used to explain variation in the speed of adjustment. The likelihood of adjustment is assumed to increase with increasing distance. If there are high fixed costs attached to the adjustment, then we expect them to increase also with increasing distance. The relations with the speed of adjustment and the distance from the optimal may either be positive indicating that large deviations are adjusted faster externally, or negative indicating respectively slower and smaller internal adjustments using e.g. flexibility.

Firm size (*SIZE*) measured as the log of total assets is also expected to be an important issue in adjustment process. Firm size is expected to be positively associated with the speed of adjustment. It can be assumed that larger firms may find it easier to adjust both their real and financial structures because of smaller information asymmetry, i.e. there is more information available. Larger firms are also generally more diversified and have access to a wider range of financial markets. These firms then face both a lower probability of bankruptcy and lower adjustment costs. As large firms can have small adjustments made relative to their total assets, but still requiring a large amount of money to be raised externally, large firms may find it more convenient to adjust faster, i.e. only when the deviations are large enough. On the other hand, the larger the firm is the less fixed adjustment costs are assumed to matter due to economies of scale in the adjustments and thus the larger firms may also have a slower adjustment speed.

We also include *cash-flow or profitability* (*CF*) and expectations of *investment opportunities* (*Q*) for the determinants of adjustment costs. This is because of their causality problems and their forward-looking nature, i.e. expectations. *CF* and *Q* are variables to be affected by using flexibility and on the other hand, they are also parts of flexibility. Indeed, we are not sure whether the correlation between investments and cash flow is caused by financial constraints or by changes in expectations of investment opportunities. Despite the unknown nature of their relations, both of the variables can be used under asymmetric information to measure signalling effects; *Q* proxies market reactions to signals whereas profitability is one of the main signalling devices available to management. We expect both variables to have a negative effect on adjustment costs: the more investment opportunities a firm has and the more profitable a firm is, the slower it is expected to adjust towards its firm-specific optimal levels of investment and debt.

Profitability (*CF*), a proxy for internal finance and future profitability, is a controversial issue, not only due to causality problems but also because of the adjustment issues. Profitability may in fact induce borrowing to reduce taxes and to control free cash-flow problems. Debt providers can also be more willing to lend because the cash-flow serves as collateral. In general, the more profitable firms have lower probability of bankruptcy and therefore, they are able to have greater leverage. This supports the information asymmetry view of financial decision-making, where internal funds are preferred to external funds. However, the higher level of profitability can also offset the need for external finance, and thus, result in lower leverage. Still in any case, more profitable firms can better support their value-adding investments. Therefore, profitability should be negatively related to both of the speeds of adjustments by allowing slower adjustment.

Tobin's Q (*Q*) measured here as the market value of capital stock to its replacement value is a basic variable explaining both the expectations of investment demand and financial capacity to implement those investment opportunities. However, Q proxies the investment opportunities only under the rational expectation hypothesis[16]. The differential between market value and fundamentals is generally attributed to "investor sentiment"[17], which creates a problem for the Q models insofar as investment decisions are based on fundamentals. Sentiments create opportunities for firms, although debatable, to use them for their own advantage. In general, growth opportunities increase information asymmetry and under-investment problems, especially if a firm is leveraged and has growth opportunities. Although the debt can control some of the free cash flow problems by limiting management's propensity to over invest, higher expected future growth usually still means a greater need for external finance. In the long run, this means a greater amount of equity and thus, lower leverage, but in the short-term, debt is preferred resulting in a higher leverage. By borrowing against future expectations, the firm will enable its current investments but will put a firm in risk of facing fluctuations in its cash flows and thus, higher cost of financing for future investments. Yet, firms with higher growth opportunities are also expected to adjust with lower costs.

5. EMPRIRICAL RESULTS

We have four goals here. First, we compare the performance of the static models serving as our reference models of investment and financing with those of the system of dynamic partial adjusting models. Second, we focus on the results of the system of

[16] Imperfect competition on markets, convex adjustment costs, heterogeneous capital markets and interaction of investment and financial decisions invalidate q-theory (Hayashi (1982) and (1985)).

[17] Investor sentiment includes e.g. excess volatility, mean reversion, fads, or speculative bubbles in financial markets.

dynamic models and investigate if and how well they match the theoretical predictions. Third, we seek to identify determinants of financial and real flexibility in investment and finance decisions. Finally, we analyse the key issue of our study, namely the interaction of real and financial flexibility and their effects on investment and finance decisions. The objective is to see whether the results improve our understanding of these interdependent interactions.

The key differences between the static models and the system of dynamic partially adjusting models are that the latter adds a lag dependent variable and flexible speed of adjustment with its cost parameters to the models and allows an interdependence between one decision to another, which is labelled as feedback. These procedures improve significantly the explanatory power of the model by increasing the adjusted R^2 and reducing the unexplained errors measured as root mean square error (*RMSE*). In the investment function, the adjusted R^2 is improved from 0.20 to 0.52 and *RMSE* reduced from 0.25 to 0.19, whereas in the financing function, the corresponding improvements are even greater: R^2 jumps from 0.10 to 0.82 and *RMSE* drops from 0.30 to 0.13. Hence, our modelling approach seems to offer a more complete picture of the firms' value creation than those found in the existing literature.

Indeed, the explanatory variables used to explain endogenous decision variables were found to be highly relevant and to have a significantly positive impact on the model performance when they are included into the system of dynamic models. The presence of the significant adjustment speed parameters and the predicted feedback effects also indicate that the dynamic system of equations is preferred to the single dynamic equation models and models excluding feedback effects. In Table 2, we provide a summary of the estimation results generated from both the static and dynamic model specifications.

5.1. Investment model

Results from the static investment model indicate that the intangible assets (IT), growth (G), internal finance (CF/A), variance of cash-flows (LVCF) and time effect are positively and significantly related to the changes in investment levels. However, in the systems of dynamic equations, all of the variables included in the static model (i.e. also real working capital (RWC), labour (L) and intercept) increase in both effects and statistical significance by maintaining signs. This indicates the relevance of the results and superiority of the system of dynamic models.

Over time, investments have decreased slightly. The strong negative intercept indicates further that firms find it relatively hard to invest or that the investments are large.

When firms undertake investment in fixed assets, they also seem to invest in real working capital, labour, and intangible assets. Real working capital has a small and positive association with investments. Labour, perhaps unexpectedly, has a large positive effect on investments, which is contrary to the case of automation or substitution of labour to fixed capital claims. As intangible assets can also capture some of the expected growth, the results show that firms in this mature industry tend also to invest in uniqueness or asset specificity. Together, the results of the labour and intangible assets suggest that the firms seem to believe quite strongly in their future investment opportunities.

The growth and cash-flow increase most dramatically in their positive effects despite the simultaneous increase in their standard deviations. This may be due to their more direct correlation with the financial variables, although growth is primarily related to investment demand, whereas the cash flow partially measuring financial flexibility is related to investment supply. Results suggest that firms that have more growth opportunities and are more profitable also tend to invest more.

The volatility of cash flows has a small but significant effect on investments. This supports the real option approach, where uncertainty increases the value of investments and thus, also the investment activity.

5.2. Financing model

The static financing model supports the theoretical prediction with regard to the tangibility of assets (K), non-debt tax shields (NDTS/A) and variance of cash flows (LVCF). Their effects are however strengthened in the system of dynamic adjustment models, in which also the financial working capital (FWC), non-debt tax shield (NDTS/CF), intercept and time-effect become significant. Interestingly, the variance of cash flows (LVCF) is an exception because it loses its statistical significance when the effects of the system are investigated.

Leverage has slightly increased during the period of the study, although intercept is found to be significant and have a high negative impact on the long-term debt. This means that firms find it relatively hard to raise debt or that the financing needs are large.

Financial working capital has a positive relationship with changes in debt levels. This supports the trade-off theory. As financial working capital measures the short-term net financing position, it may also act as partial collateral for lenders, thereby reducing the probability of bankruptcy and enabling higher leverage.

The high negative relationship between the first measure of the non-debt tax shields (*NDTS/A*) relative to total assets supports predictions made by the trade-off theory. However, the other measure of non-debt tax shields (*NDTS/CF*) to cash-flows shows a slightly positive relation with debt levels. These opposite effects may be a result of the fact that the variables measure different aspects of the capital structure. Indeed, the first measure can capture more of the uniqueness of assets than the effect of non-debt tax shields, because it measures the duration of capital stock in reverse manner and thus, actually the amount of information asymmetry. The latter measures the tax-effects of the non-debt tax shields on cash flows more directly.[18]

It should also be noted that depreciation and other provisions capture only partially the non-debt tax shields that are substitutes for the interest rate tax-shields. This is because they are associated with fixed asset and thus, the measure ignores more intangible tax deductions. The positive relation with debt and non-debt tax shields can be explained by Scott's (1977) secured debt hypothesis, where high investment in tangible assets create high levels of non-debt tax shields but low borrowing cost due to high collateral value. Thus, Scott's hypothesis also relates the debt capacity to asset tangibility. Tangibility of assets is positively related to leverage as is predicted by all the corporate finance theory

[18] Titman and Wessels (1988) show very similar results and provide a more thorough analysis of the existing contradiction between the two non-debt tax shield measures.

strands and many empirical studies as well. Hence, tangible assets serve as collaterals that enhance debt capacity by lowering the costs of raising debt.

Interestingly, volatility of cash flows, which is important and weakly significant in the static model, is insignificant in the system model. It seems that volatility of cash-flows does not have any effect on the debt levels or financial status of firms.

5.3. Feedback effects

Looking at the feedback effects indicated by parameters α_F and β_R, we see that the effects of predicted debt ($\hat{F}$) and investment ($\hat{R}$) variables are close to being equal with high positive and significant effects on the respective models. Thus, the system seems to be relatively balanced, as proved by the symmetric feedback effects. The results indicate that an increase in debt increases investments and *vice versa*. This shows that investments are on average too large to be financed with pure flexibility and thus, they are financed primarily using debt. Hence, these feedback effects show that there is an interaction with the real and financial decisions, which contradicts the hypothesis of perfect and complete markets.

5.4. Adjustment costs

Both the speeds of adjustments have increased slightly over time, although the rise in investment speed of adjustment has been almost double compared with the one in the financing case. High negative and significant intercept in financial speed of adjustment means that the adjustments to be made are large or the adjustment costs are high. The null hypothesis of intercept is, however, not rejected in the case of the investment speed of adjustment.

The distance is strongly and positively related to the speed of adjustment in both of the models. This is logical, especially if the adjustment costs are high, because as the distance to the optimal grows so do the costs related to it and thus, the faster firms want to adjust to their firm-specific optimal levels. This lends support to the view of convex adjustment costs. As this effect is twice as large in the financial adjustment as it is in the investment adjustment, the importance of maintaining the financial optimal is emphasized even at the expense of optimal investments.

Profitability is found to have a strong and negative impact on changes in the speed of adjustment in both the investment and finance decisions. This indicates that more profitable firms have more time to adjust their investments and financing. The pattern also highlights the importance of internal financing as a source of flexibility in both the decisions. Still, the effect of profitability in financing adjustment is more than twice that in investment adjustment process. This is an indication that there can also be other variables playing a role in the investment adjustment process.

Growth opportunities and size do not seem to matter, as they were found to be statistically insignificant. This may relate to an industry-specific phenomenon and our selection criteria, where only firms with total sales over USD 200M were included. The insignificance of growth opportunities could also indicate that the rational expectation hypothesis does not apply.

5.5. Speeds of adjustments

Table 3 represents the mean values of the parameters of the speeds of adjustments. The speed of adjustment in the investment model is positive and increasing over time. There are even signs of over-adjustment in the last few years. Still, the adjustment parameter is not constant, as commonly assumed in conventional dynamic models and hence, the models with flexible adjustment parameters should be preferred. The results also show severe under-investment, because the optimal and observed levels of investment deviate greatly from each other. This lends support to the on-going consolidation in the industry. The larger deviations together with the higher speed of adjustment result in a faster adjustment of the observed to optimal level of investment. The large swings observed in the optimal and observed investments also cause the optimality ratio to fluctuate widely. The swings are probably caused by the large investments, e.g. mergers and acquisitions, which need time to be digested and accomplished.

The speed of adjustment in the financial model starts from the negative values and then increases over time to become positive. It seems that firms first use internal flexibility and then after the exhaustion of the internal financial flexibility, acquire external financing. This could indicate a counter cyclical behaviour. Still, the adjustment speed in general is quite low, which means that firms believe that they are in their optimal. According to the results, firms are, however, more leveraged than the optimal would suggest. This is further supported by the earlier under-investment claim. Finally, both the optimal and observed leverage fluctuate quite widely and as a result, the optimality ratio varies, but with a tendency to grow over time.

In Table 4, we report the correlations between the speeds of adjustments and other relevant variables. The speed of adjustment in investments increases strongly over time, while the optimal and observed investments decrease slightly. As a result, the optimality ratio of investments also decreases over time. The optimal and observed investments are positively correlated with both the adjustment speeds and each other. The speed of adjustment in financing increases over time and relative to the optimal and observed debt levels, which are themselves positively correlated with each other and over time. Thus, the optimality ratio of debt increases over time.

The speed of adjustments in investments and the observed investments are positively correlated with all the financial adjustment parameters indicating that the investments are financed largely externally with debt. Interestingly, the speed of adjustment in financing and the optimality ratios in financing and investments are negatively correlated, which means that the larger deviations are adjusted more slowly, perhaps due to high financial adjustment costs. This would indicate serious market imperfections caused by financial adjustment costs. These costs have severe a negative impact on investments and financing decisions and could cause mean reversion in the investment and debt ratios. It seems that at least in this industry, the financial adjustment costs are more restrictive factors for a firm's value creation than the investment adjustment costs.

6. SUMMARY AND CONCLUSIONS

This paper aims at improving our knowledge of joint and interdependent firm investment and financing decisions. Hence, we have analysed the interaction of firm flexibilities and their effects on these decisions. We have argued that both real and financial flexibilities can be used to delay or smooth the effects of more permanent and costly changes in investment and debt levels. To study these flexibilities and their interactions as well as effects on the decisions, we have introduced a system of interdependent dynamic partial adjustment models that allows us to estimate and analyse the indicators of flexibility: speed, costs, and efficiency of the firm-specific adjustments towards the optimal, and the feedback effects from one decision to another. The empirical analysis is based on a large sample of paper and pulp producing multinational companies observed during the period 1992 to 2002.

The empirical results show that our dynamic formulation dramatically improves the explanatory power of the model compared to the static models. Furthermore, the independent variables used to explain investment and financing decisions increase in their effect and significance while maintaining expected signs. We find also that investments have slightly decreased over time and have a positive relationship with all the explanatory variables: real working capital, intangible assets, labour, growth, cash flows and variance of cash-flows. Leverage has instead increased over time and is positively related to financial working capital, tangible assets, and non-debt tax shields to cash flows. The non-debt tax shields to total assets, i.e. measure of uniqueness of assets, have instead negative effect on the leverage. The variance of cash flows is found to be insignificant. The feedback effects from one sub-model to another are found to be strongly positive and approximately of equal size, thereby showing a strong interdependence between the two decisions.

The speed of adjustment is expected to proxy adjustment costs (distance, size, profitability, and expected investment opportunities) and partially flexibility. Absolute distance has positive and profitability negative effect on the adjustment speed. The effect of distance lends support to the convex adjustment costs, i.e. the farther a firm is from its optimal the faster it adjusts towards it. Profitability indicates instead that more profitable firms have more time to adjust their investment and financing levels. In addition, the results show that the effects of distance and profitability to the adjustment speeds are twice as large in financing as they are in investments. Size and market-to-book value show insignificant effects on the speeds of adjustments.

The speeds of adjustments in both cases increase over time, but they are not constant as commonly assumed in traditional dynamic models and hence, the models with flexible adjustment parameters like ours should be preferred. The results show severe under-investment but slight over-leverage among the sample firms. The firms also seem to adjust their leverage first internally and then after the exhaustion of internal resources, externally by using debt financing. The speeds of adjustments in investments and financing are positively correlated with each other, which further emphasizes the interaction of the real and financial decisions. The speed of adjustment in investment is also positively correlated with the optimality ratio of debt. However, the speed of adjustment in financing is negatively correlated with both of the optimality ratios. This means that the larger in-optimalities in investment and financing are adjusted more slowly because of the high adjustment costs in financing. This is an indication of serious market imperfections as a form of financial constraints. As a result, the interaction with the investment and finance decisions and the flexibilities related to them is indisputable and thus, contradicts the perfect and complete market hypothesis.

With respect to the implications of our findings, we would like to emphasise that as investment and financial adjustments are controlled by the endogenous and interacting flexibilities, it is therefore hard to make any suggestions regarding policy interventions. The results are, however, tentative and should thus be interpreted with caution. At the firm level, we note that although real and financial flexibility interact, the financial flexibility is more visible to markets and thus, the adjustment costs related to it are likely to dominate both the investment and financing adjustment processes. However, stronger evidence is needed for making inferences. Therefore, we encourage systematic application of similar modelling techniques to a wider range of industries and firms with more heterogeneous sizes, and perhaps preferably covering a longer period of time. Different mixes of variables for the adjustment costs and determinant variables across investment and debt equations could also give new insights into the nature of the relations studied and the adjustment processes that are so important to corporate value creation.

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Table 1. Summary statistics of the data, NT=629, 1994-2002.

Variable	Mean	Std. Dev	Minimum	Maximum
I	0.095	0.276	-0.411	2.228
RWC	0.287	0.512	-2.553	5.010
IT	0.097	0.216	0.000	1.726
L	0.006	0.011	0.000	0.161
G	0.104	0.312	-0.790	5.323
CF/K	0.243	0.243	-0.337	3.489
D	0.256	0.317	0.000	6.296
FWC	-0.044	0.138	-0.968	0.756
K	0.567	0.227	0.117	2.083
NDTS/A	0.053	0.046	-0.053	0.612
NDTS/CF	0.499	0.461	-1.048	6.273
SIZE	6.847	1.104	0.000	9.495
Q	1.279	1.594	-9.266	9.940
CF/A	0.122	0.113	-0.170	1.290
VCF	4.1161571E14	2.6747717E15	3463712.00	2.2003429E16
K	63222023.11	226044952.98	30172.00	2018017792.00
A	122873017.75	400278944.46	49441.00	3123862784.00
CF	9324291.83	35477425.21	-227623248.00	355036928.00

Notes: Investment (I), real working capital (RWC), intangible assets (IT), labour (L), growth (G), fixed assets (K), assets (A), cash-flows (CF), long-term debt (D), non-debt tax shields (NDTS), firm size (SIZE), investment opportunity (Q), variance of cash flow (VCF).

Table 2. Single static and system of dynamic partial adjusting models parameter estimates, NT=629.

Variables	Single static models		System of dynamic models	
Variables	Estimates	Std. Errors	Estimates	Std. Errors
A. Determinants of investment equation:				
α_0	-0.1384.	0.0740	-0.5792a	0.0744
α_{RWC}	-0.0105.	0.0202	0.0850a	0.0146
α_{IT}	0.1344b	0.0502	0.1505a	0.0322
α_L	2.0043.	1.0741	2.1601c	0.9036
α_G	0.2743a	0.0334	1.1510a	0.2262
α_{CF}	0.2007a	0.0470	1.6143a	0.2867
α_{LVCF}	0.0078b	0.0024	0.0135a	0.0021
α_T	-0.0089c	0.0040	-0.0266a	0.0037
α_D			1.8679a	0.0942
B. Determinants of financing equation:				
β_0	0.1360.	0.0917	-0.7821a	0.0725
β_{FWC}	0.0601.	0.0934	0.1920c	0.0793
β_K	0.4423a	0.0550	0.8506a	0.0474
$\beta_{NDTS/A}$	-0.7909b	0.2957	-1.8535a	0.1897
$\beta_{NDTS/CF}$	0.0236.	0.0265	0.0907b	0.0330
β_{LVCF}	-0.0064c	0.0028	0.0002.	0.0019
β_T	0.0090.	0.0048	0.0511a	0.0056
β_I			1.7759a	0.0634
C. Determinants of speed of adjustment in investment equation:				
ς_0			0.1818.	0.2028
ς_{SIZE}			0.0004.	0.0262
ς_{CFA}			-0.4586b	0.1545
ς_Q			-0.0064.	0.0144
ς_T			0.0781a	0.0119
ς_{IDIST}			0.3751a	0.0493
D. Determinants of speed of adjustment in financing equation:				
ξ_0			-0.3472b	0.1168
ξ_{SIZE}			0.0020.	0.0149
ξ_{CFA}			-1.1055a	0.0887
ξ_Q			-0.0102.	0.0096
ξ_T			0.0412a	0.0066
ξ_{DDIST}			0.7452a	0.0513
Performance of the models:				
	Single static models		*System of dynamic models*	
	Investment	*Financing*	*Investment*	*Financing*
Adj. R^2	0.2004	0.0968	0.5201	0.8238
RMSE	0.2472	0.3012	0.1915	0.1331

Notes: Significant at the less than 1%(a), 1-5%(b), 5-10%(c), and more than 10%(.) level of significance.

Table 3. Mean variables by year, NT=629.

Year	Speed of adjustment, δ_R	Optimal investment, R*	Observed investment, R	Optimality ratio, R*/R	Speed of adjustment, δ_F	Optimal leverage, F*	Observed leverage, F	Optimality ratio, F*/F
1994	0.560	0.647	0.097	6.675	-0.165	0.026	0.239	0.110
1995	0.722	0.877	0.208	4.221	-0.116	0.215	0.240	0.897
1996	0.689	0.476	0.080	5.982	-0.067	0.051	0.212	0.239
1997	0.797	0.537	0.086	6.263	-0.018	0.131	0.256	0.511
1998	0.901	0.608	0.171	3.552	0.028	0.197	0.289	0.680
1999	0.927	0.537	0.026	20.695	0.047	0.158	0.230	0.685
2000	1.099	0.737	0.087	8.468	0.043	0.287	0.256	1.118
2001	1.084	0.482	0.080	6.002	0.116	0.237	0.243	0.975
2002	1.146	0.392	0.037	10.648	0.176	0.294	0.341	0.863

Table 4. Correlation matrix of the adjustment parameters, NT=629.

	Year	Speed of adjustment, δ_R	Optimal investment, R*	Observed investment, R	Optimality ratio, R*/R	Speed of adjustment, δ_F	Optimal leverage, F*	Observed leverage, F	Optimality ratio, F*/F
Year	1.000								
δ_R	0.764a	1.000							
R*	-0.124b	0.359a	1.000						
R	-0.101c	0.227a	0.579a	1.000					
R*/R	-0.121b	-0.012.	0.196a	0.198a	1.000				
δ_F	0.412a	0.300a	-0.281a	0.003.	-0.158b	1.000			
F*	0.210a	0.486a	0.660a	0.581a	0.138b	0.221a	1.000		
F	0.058.	0.112b	0.104b	0.224a	0.001.	0.371a	0.491a	1.000	
F*/F	0.201a	0.318a	0.448a	0.223a	0.177b	-0.189a	0.548a	0.046.	1.000

Notes: Significant at the less than 1%(a), 1-5%(b), 5-10%(c), and more than 10%(.) level of significance.

Appendix 1. Description of the data and variables.

Data source:	DATASTREAM - Company account data
Date:	August 8, 2003

Search criteria:

Datatype	*Limitation*	*Unit*	*No. of matches*
Composite code	ALL AREAS		
Industry classification	PAPER	Default	363
Total sales	OVER200	MILLIONS	5903
No. of total matches:	87		
Time period:	1992-2002, annualised		
Total no. of observation:	957		

Data types:

Datastream item	*Description*
104	Total sales
696	Depreciation and operating provisions
1502	Earnings before Interest, Tax, Depreciation and Amortisation
305	Equity capital and reserves
309	Borrowings repayable within 1 year
321	Total loan capital (repayable after 1 year)
339	Total fixed assets – net
344	Total intangibles
375	Total cash and equivalent
376	Total current assets
389	Total current liabilities
392	Total assets
MV	Market value / market capitalisation
NTA = 305 - 344	Net tangible assets/ Book Value
219	Total number of employees

Definition of variables included in the models:

Symbol	*Definition*
K	Total fixed assets – net (339)
R	New fixed investments = K_t-K_{t-1}
RWC	Real Working Capital = Total current assets (376) - Total current liabilities (389) - FWC
FWC	Financial Working Capital = Total cash and equivalent (375) - Total loan capital (repayable within 1 year) (309)
IT	Total intangibles (344)
L	Total number of employees (219)
G	Growth = ($Sales_t$- $Sales_{t-1}$)/ $Sales_{t-1}$, Sales = Total sales (104)
CF	Earnings before Interest, Tax, Depreciation and Amortisation (EBITDA) (1502)
LVCF	Log(variance of (CF))
NDTS	Non-Debt Tax Shields = Depreciation and operating provisions (696)
A	Total assets (392)
F	Total loan capital (repayable after 1 year) (321)
SIZE	Log(A)
Q	Market value (MV) / Book value (NTA=equity capital and reserves (305) - total intangibles (344))

Appendix 2. Pearson correlation coefficients for various variables.

	Year	R	RWC	IT	L	G	CF/K	F	FWC	K	NDTS/A	NDTS/CF	SIZE	Q	CF/A	LVCF
year	1.000															
R	-0.101	1.000														
p-value	0.010															
RWC	0.068	0.005	1.000													
p-value	0.087	0.897														
IT	0.163	0.164	0.028	1.000												
p-value	0.001	0.001	0.472													
L	-0.047	0.132	0.124	0.342	1.000											
p-value	0.238	0.001	0.001	0.001												
G	-0.059	0.373	-0.066	0.063	0.038	1.000										
p-value	0.137	0.001	0.096	0.111	0.330											
CF/K	-0.041	0.291	0.242	0.231	0.324	0.289	1.000									
p-value	0.299	0.001	0.001	0.001	0.001	0.001										
F	0.058	0.224	-0.135	0.219	0.070	0.571	-0.038	1.000								
p-value	0.139	0.001	0.001	0.001	0.078	0.001	0.334									
FWC	-0.082	-0.003	-0.169	0.050	-0.037	-0.007	0.098	0.064	1.000							
p-value	0.038	0.940	0.001	0.204	0.346	0.858	0.013	0.105								
K	-0.068	0.626	-0.240	0.010	-0.062	0.359	0.057	0.283	0.015	1.000						
p-value	0.085	0.001	0.001	0.797	0.120	0.001	0.151	0.001	0.704							
NDTS/A	-0.045	0.258	0.062	0.089	0.409	0.120	0.380	-0.028	-0.262	0.217	1.000					
p-value	0.256	0.001	0.119	0.025	0.001	0.002	0.001	0.482	0.001	0.001						
NDTS/CF	0.046	-0.037	0.025	0.058	0.045	-0.065	-0.076	-0.002	-0.068	-0.095	0.133	1.000				
p-value	0.245	0.348	0.520	0.145	0.259	0.103	0.055	0.949	0.088	0.016	0.001					
SIZE	0.034	0.017	-0.034	-0.137	-0.441	-0.040	-0.233	-0.039	-0.171	-0.075	-0.280	-0.020	1.000			
p-value	0.387	0.665	0.391	0.001	0.001	0.306	0.001	0.321	0.001	0.056	0.001	0.610				
Q	-0.153	-0.083	-0.036	-0.139	0.041	-0.029	0.026	-0.065	-0.038	-0.025	0.021	0.045	-0.021	1.000		
p-value	0.001	0.036	0.360	0.001	0.294	0.453	0.499	0.099	0.337	0.524	0.592	0.253	0.592			
CF/A	-0.081	0.328	0.058	0.118	0.310	0.336	0.878	0.013	0.051	0.314	0.586	-0.112	-0.257	0.030	1.000	
p-value	0.039	0.001	0.145	0.002	0.001	0.001	0.001	0.739	0.200	0.001	0.001	0.004	0.001	0.438		
LVCF	-0.054	0.047	-0.040	-0.118	-0.424	-0.025	-0.184	-0.071	-0.126	0.007	-0.251	-0.077	0.918	-0.063	-0.178	1.000
p-value	0.173	0.230	0.312	0.002	0.001	0.524	0.001	0.072	0.001	0.858	0.001	0.052	0.001	0.111	0.001	