The Dynamics of Capital Structure : Panel Data Analysis Evidence From New High-Tech German Firms

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Abstract

In this research, we investigate the dynamic of the capital structure, using panel data techniques. A sample of new high-tech German firms over the period 1998-2002 is used to specifically establish the determinants of a time-varying optimal capital structure.

We consider the dynamic models, introducing the Anderson and Hsiao (1981) estimators and the critical distinction between fixed and random effects.

This is the first time the scope of studying the dynamic of the capital structure has been extended to new high-tech firms with the use of many techniques of panel data. Confirming the pecking order model but contradicting the trade off model, we find that more profitable firms use less leverage. We also find that large companies tend to use more debt than smaller companies, and that firms which have high operating risk can lower the volatility of the net profit by reducing the level of debt. Leverage is also closely related to tangibility of assets and to the ratio of non-debt tax shield. Finally, estimating a dynamic panel data model, we find that new high-tech German firms adjust their target ratio very quickly.

1 Introduction

The basic objective of any corporate finance study of capital structure is to identify factors explaining the firm's decision with respect to its financial leverage. Starting with Miller and Modigliani (1958), the literature on capital structure has been expanded by many theoretical and empirical contributions. Much emphasis has been placed on releasing the assumptions made by MM, in particular

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by taking into account corporate taxes (Modigliani and Miller, 1963), personal taxes (Miller, 1977), bankruptcy costs (Stiglitz, 1972; Titman, 1984), agency costs (Jensen and Meckling, 1976; Myers, 1977), and informational asymmetries (Myers, 1984).

Two main theories dominate currently the capital structure debate: the Trade-Off Theory (TOT) and the Pecking Order Theory (POT). According to Stewart C. Myers, the trade-off theory says that firms seek debt levels that balance the tax advantages of additional debt against the costs of possible financial distress. The pecking order theory says that the firm will borrow, rather than issuing equity, when internal cash flow is not sufficient to fund capital expenditures. Thus the amount of debt will reflect the firm's cumulative need for external funds.

Consequently, the aim of our research is to study the association between observed leverage and a set of explanatory variables, using panel data analysis to establish the determinants of a time varying optimal capital structure from new high-tech firms over the period 1998-2002, and to explore whether the main theories of firm financing (Trade-Off Theory and Pecking Order Theory) can explain the capital structure of these firms. We will use annual data from 99 German firms on the Deutsch Boerse. A total of 476 observations are available for analysis.

New high technology firms, for purposes of this research, include firms in many sectors such as Biotechnology, Software, Information Technology Services, Internet, ...There was an unprecedented flow of venture capital to these firms over the last years.

The latter sectors are of particular interest because of the nature of their activities. On the one hand, high-tech firms are projected to grow faster than nontechnology companies, they may not be able to rely on cash flow to finance growth because they market overseas twice as often as nontechnology firms. On the other hand, the squeeze on profit margins may restrict the amount of their cash that can be directed toward financing growth.

So, as the Foreign Minister of Germany remarked, it is often argued that a bank-based system like Germany suffers from inadequate financing of young and innovative firms. But, following the famous Modigliani and Miller theorem (Modigliani-Miller, 1958), the way a firm is financed does not matter. Thus, high-tech firms could either be financed via debt or equity. However, to get the necessary financing, high-tech companies turned to nontraditional sources.

Moreover, these firms often suffer the problems associated with asymmetric information, such as adverse selection and moral hazard. In this way, they are affected by the typical problems studied in the theory of pecking order.

Nevertheless, these firms could also set their financial policy by following a target indebtedness ratio, as maintained by trade off theory.

Thus, our focus is on answering three questions: Do corporate financial leverage decisions differ significantly for new high-tech firms? Are the factors that affect their capital structure similar to those determined for other firms? And finally, are both theories, trade-off theory and pecking order theory, enable us to describe the financial behavior of new high-tech German firms?

Regarding methodology, this study attempts to empirically determine the factors that affect the optimal debt level by using the panel data analysis. In so doing, we will also be able to capture the dynamics of capital structure adjustments, and the speed with which they do that. Thus, as a solutions to problems of heteroskedasticity and autocorrelation, and for the purpose of comparison we will study both static and dynamic panel models based on the book value measures of leverage. Each kind of model needs different diagnostic tests and different estimation techniques in order to achieve efficient and consistent estimators.

In section 2 we review related empirical studies. In section 3 we proceed with the description of the determinants of the capital structure. In section 4 the process of sample selection is explained and the data is described. Section 5 covers the model specification and discusses the principal problems of estimating with panel data models. Section 6 presents the main empirical results. Finally, section 7 concludes.

2 Related empirical studies

Over the years numerous studies on capital structure theory have appeared. Modigliani and Miller (1958) were the first who theorized the issue by illustrate that the valuation of a firm will be independent from its financial structure under certain key assumptions. Internal and external funds may be regarded as perfect substitutes in a world where capital markets function perfectly, where there are no transaction or bankruptcy costs and the firm cannot increase its value by changing its leverage.

Five years later, Modigliani and Miller (1963) argue that, due to tax deductibility of interest payments, companies may prefer debt to equity. They showed that borrowing would only cause the value of the firm to rise by the amount of the capitalized value of the tax subsidy. However, Miller (1977) emphasizes the effect of personal taxation. Moreover, DeAngelo and Masulis (1980) argue that interest tax shields may be unimportant to companies with other tax shields, such as depreciation. Based on asymmetric information, Meyers and Majluf (1984) predict that companies will prefer internal to external capital sources.

Most empirical researches of capital structure are not recent (Taggart, 1977; Marsh, 1982; Jalilvand and Harris, 1984; Titman and Wessels, 1988). Those authors made a significant contribution in formulating and testing the determinants of the capital structure, but they caution on the difficulty of finding suitable proxies for these determinants.

In their cross-sectional study, Rajan and Zingales (1995) attempt to test for the G-7 countries the extent to which at the level of the individual firm, leverage may be explained by four key factors, market to book, size, profitability and tangibility. These authors find similar levels of leverage across countries, the determinants of capital structure that have been reported for the US are important in other countries as well.

While financial economists have devoted considerable attention to empirically testing theories of optimal capital structure, relatively little research has focused on explaining the dynamics of a firm's capital structure. These researches may be classified into two groups depending on whether they utilize cross-sectional or time-series data. Fisher, Henkel, and Zechner (1989) use cross-sectional data in testing their model of the optimal dynamic capital structure and the presence of transactions costs. They attempt to employ a dynamic approach to study capital structure to the extent that they study the factors that determine the firm's debt ratio range, defined as the difference between its maximum and minimum debt ratio.

The second group of studies of capital structure dynamics utilizes pooled time-series/cross-sectional data (Taggart, 1977; Marcus, 1983; Jalilvand and Harris, 1984; Sharpe, 1991). In the presence of adjustment costs, firms are assumed to gradually adjust their capital ratio at a constant rate so as to eliminate deviations between their optimal (or desired) and actual capital ratio.

Other recent studies, which have considered capital structure dynamics, offer better insight on the adjustment process toward the target debt-to-equity ratio (Kremp et al, 1999; De Miguel and Pindado, 2001; and Ozkan, 2001). Kremp et al (1999) analyze a large panel of French and German firms and confirm the existence of a dynamic adjustment process stress the role of Husband System in Germany, and the impact of tax policy and the end of the so-called "indebtedness economy" in France. These findings are confirmed by De Miguel and Pindado (2001) who show that firms have a target leverage ratio in Spain, and that companies adjust to the target ratio relatively fast.

3 Determinants of capital structure

Prior research on capital structure by Rajan and Zingales (1995) suggests that the level of leverage in UK companies is positively related to size and tangibility, and negatively correlated with profitability and the level of growth opportunities. However, as argued by Harris and Raviv (1991), "The interpretation of results must be tempered by an awareness of the difficulties involved in measuring both leverage and the explanatory variables of interest".

In this section, we provide a review of the six main variables that have been used in previous studies examining the determinants of capital structure.

3.1 Growth opportunities

The empirical evidence regarding the relationship between leverage and growth opportunities is rather mixed. While Titman and Wessels (1988), Chung (1993) and Barclay et al. (1995) find a negative correlation, Kester (1986) does not find any support for the predicted negative relationship between growth opportunities and gearing. Despite this controversy, Rajan and Zingales (1995) uncover evidence of negative correlations between market-to-book and gearing for all G-7 countries. They suggest that, a priori, one would expect a negative relation between growth opportunities and the level of leverage.

This is consistent with the theoretical predictions of Jensen and Mekling (1976) based on agency theory, and the work of Myers (1977), who argues that, due to information asymmetries, companies with high gearing would have a tendency to pass up positive net present value investment opportunities (also known as growth options). Myers therefore argues that companies with large amounts of investment opportunities would tend to have low gearing ratios.

3.2 Size

Large size companies tend to be more diversified, and hence their cash flows are less volatile. Size may then be inversely related to the probability of bankruptcy (Titman and Wessels, 1988; Rajan and Zingales, 1995). Ferri and Jones (1979) suggest that large firms have easier access to the markets and can borrow at better conditions. For small firms, the conflicts between creditors and shareholders are more severe because the managers of such firms tend to be large shareholders and are better able to switch from one investment project to another (Grinblatt and Titman, 1998).

Size can serve as an indicator of riskiness of the firm in that:

· Smaller firms have higher product market risk,

· Small firms have a higher probability to be takeover targets.

· According to Whited (1992) small firms cannot access long-term debt markets since their growth opportunities exceed their assets. Titman and Wessels (1988) argue that larger firms have easier access to capital markets.

Rajan and Zingales include size in their cross-sectional analysis. They say that: "The effect of size on equilibrium leverage is more ambiguous. Larger firms tend to be more diversified and fail less often, so size may be an inverse proxy for the probability of bankruptcy".

3.3 Profitability

One of the main theoretical controversies concerns the relationship between leverage and profitability of the firm. Profitability is a measure of earning power of a firm. The earning power of a firm is the basic concern of its shareholders.

According to the pecking order theory, firms prefer using internal sources of financing first, then debt and finally external equity obtained by stock issues. The more profitable firms are, the more internal financing they will have. This relationship is one of the most systematic findings in the empirical literature. In a trade-off theory framework, an opposite conclusion is expected. When firms are profitable, they should prefer debt to benefit from the tax shield. In addition, if past profitability is a good proxy for future profitability, profitable firms can borrow more as the likelihood of paying back the loans is greater.

3.4 Tangibility

Previous empirical studies by Titman and Wessels (1988), Rajan and Zingales (1995) and Fama and French (2000) argue that the ratio of fixed to total assets (tangibility) should be an important factor for leverage. The tangibility of assets represents the effect of the collateral value of assets of the firm's gearing level.

Tangibility is defined as the ratio of tangible assets to total assets. Harris and Raviv (1990) predicts that firm with higher liquidation value will have more debt. On the contrary, intangible assets such as good will can lose market value rapidly in the event of financial distress or bankruptcy. Firms with more tangible assets usually have a higher liquidation value.

Tangible assets are likely to have an impact on the borrowing decisions of a firm because they are less subject to informational asymmetries and usually they have a greater value than intangible assets in case of bankruptcy. Additionally, the moral hazard risks are reduced when the firm offers tangible assets as collateral, because this constitutes a positive signal to the creditors who can request the selling of these assets in the case of default. As such, firms with a higher proportion of tangible assets are more likely to be in a mature industry thus less risky, which affords higher financial leverage.

3.5 Non-debt tax shield

Firms will exploit the tax deductibility of interest to reduce their tax bill. Therefore, firms with other tax shields, such as depreciation deductions, will have less need to exploit the debt tax shield. Ross (1985) argues that if a firm in this position issues excessive debt, it may become "tax-exhausted" in the sense that it is unable to use all its potential tax shields. In other words, the incentive to use debt financing diminishes as non-debt tax shields increase. Accordingly, in the framework of the trade-off theory, one hypothesizes a negative relationship between leverage and non-debt tax shields. In fact, the empirical evidence is mixed.

Shenoy and Koch (1996) find a negative relationship between leverage and non-debt tax shield,while Gardner and Trcinka (1992) find a positive one.

3.6 Operating risk

Many authors have included a measure of risk as an explanatory variable of the debt level (Titman and Wessels, 1988; Kremp et al., 1999; Booth et al., 2001). Leverage increases the volatility of the net profit. Firms that have high operating risk can lower the volatility of the net profit by reducing the level of debt. By so doing, bankruptcy risk will decrease, and the probability of fully benefiting from the tax shield will increase. A negative relation between operating risk and leverage is also expected from a pecking order theory perspective: firms with high volatility of results try to accumulate cash during good years, to avoid under investment issues in the future.

Below, I present in table 1 the Trade-Off Theory versus the Pecking Order Theory. This table summarizes the different predictions for the relationship between leverage and our explanatory variables for both the trade-off theory and the pecking order theory.

Table 1
Trade-Off Theory versus Pecking Order Theory

	Leverage	
	Trade-Off Theory	**Pecking Order Theory**
Tangibility	Positive	
Size	Positive	Negative
Growth	Negative	Positive or Negative
Profitability	Positive	Negative
Risk	Negative	Negative
Non-Debt Tax Shield	Negative	

4 Sample selection and data description

4.1 Sample selection

Our sample consist of new high technology German firms listed on the Deutsche Boerse for the period 1996-2002. We use annual data extracted from http://deutsche-boerse.com. This website provides many information on many indices. It is owned by the private company that runs the Frankfurt Stock Exchange: the Deutsche Boerse AG.

The data set includes a wide array of information on the companies including the annual Balance sheet, the Statement of income, the Statement of cash flow and the Profit and Loss Account.

All data were hand-collected from 500 annual reports of the selected firms at http://deutsche-boerse.com. From these reports, we made extract information necessary for our analysis, such as operating income, total assets, net income, depreciation, tangible assets, total equity, total debt...Then, we filled our data base on Excel. Finally, we imported our data on Eviews as a pooled data. This work was our starting point, it required much time and concentration.

Some firms report annual financial statements in a summarized manner. For example, one firm reports its quarterly financial statements in March, in June, in September and in December, but it doesn't report an annual financial statements which includes figures the year. So, we were obliged to do some preliminary calculus to have the desired amounts of variables in an annual basis.

Some other firms use the American dollar (USD) in their reports. So, we had to look for the average currency exchange rates observed during the considered quarter in order to convert the amount into (EUR).

Our sample thus contains Biotechnology, Financial Services, Industrial & Industrial Services, Internet, IT Services, Media & Entertainment, Medtech & Health Care, Software, Technology and Telecommunication sectors.

Table 2 shows the sample classification by sector and the percentage represented by each sector in the whole sample on 13/05/2003.

Table 2

Sample representation by sector

	Sectors	**Firms**	**%**
Sector 1	Biotechnology	11	11,1
Sector 2	Industrial & Industrial services	12	12,3
Sector 3	Internet	7	7
Sector 4	IT-Services	11	11,1
Sector 5	Medtech & Health care	4	4
Sector 6	Media & Entertainment	11	11,1
Sector 7	Technology	31	31,4
Sector 8	Telecommunication	5	5
Sector 9	Software	7	7
Total		99	100

From this sample only firms with at least four years of complete data and non-missing observations on key variables were retained. We also exclude observations for which we have negative figures on the balance sheet. As a result, the final sample consists of a pool of 99 firms. For these firms, the yearly data is from 1998-2002. This leaves us with a total of 467 observations. This panel character of our data allows us to use panel data methodology, simultaneously combining cross section and time series data.

4.2 Description of the data

After looking at the sample selection, we took great care to define the dependent and independent variables to be used in this analysis, in order that they were consistent with those of Rajan and Zingales (1995). However, whilst they define and calculate several alternative measures of leverage, their cross-sectional regression analysis is merely based upon one of these measures.

Of these we use a book value measure of leverage (LEV) defined as the ratio of book value of debt to the sum of book values of debt and equity, as a dependent variable in our analysis. The evolution of the mean leverage ratio over the period of analysis, 1998-2002, for global sample is presented in table 3.

Table 3

Mean Leverage ratio by year

	LEV	
YEAR	MEAN	SD
1998	0.510212	0.577845
1999	0.430558	0.253943
2000	0.435823	0.212993
2001	0.473090	0.211541
2002	0.504035	0.239274

It is interesting to compare our level of leverage with the results reported by Rajan and Zingales (1995) for their sample of G-7 countries. When leverage is defined as debt over capital, Rajan and Zingales (1995) report that U.S. and German firms have similar leverage around 38 per-cent. Interestingly, with this definition, our results deal with leverage ratios around 50 per-cent.

4.3 Explanatory variables

As discussed above, our set of explanatory variables consists of those that have commonly been documented in the literature to affect firm leverage. we adopt six independent variables, defined as follows:

· Growth opportunities (**GROW**): we use the percentage change in total assets from the previous to the current year as an empirical measure for the growth opportunities.

· Size (**SIZE**): we use the logarithm of total assets to test the effect of firm size on the optimal debt level.

· Profitability (**PROF**): we use the ratio of net income to total assets as a measure of profitability.

· Tangibility (**TANG**): That is defined as the ratio of tangible assets to total assets.

· Non-Debt Tax Shield (**NDTS**): we use total depreciation from the firm's profit and loss account divided by total assets as the empirical measure for non-debt tax shield.

· Operating Risk (**RISK**): we use the squared difference between the firm's profitability and the cross section mean (across firms) of profitability for each year as a measure of the operating risk.

Table 4 lists and defines the variables we will use in the study. These variables account for almost all major income statement, balance sheet and profit and loss account line items. All data were hand-collected from annual reports of the selected firms at http://deutsche-boerse.com.

Table 4

Data sources and variable definitions

This table presents description of the variables used in our estimations. Data are from annual reports of German firms available at http://deutsche-boerse.com.

Abbreviation	Description
TA	Total assets from the balance sheet
DEBT	Total debt from the balance sheet
EQUITY	Sher-holder equity from the balance sheet
NI	Net Income from income statement
TANG	Tangible assets from balance sheet / TA
DEP	Total dereciation from profit and loss account
GROW	$(TA_t - TA_{t-1}) / TA_{t-1}$
SIZE	Log(TA)
PROF	NI / TA
NDTS	DEP / TA
RISK	$(PROF_{firm} - PROF_{mean})^2$
LEV	DEBT / (DEBT+EQUITY)

Bellow, we present in table 5 the main descriptive statistics of those measures of all the observations. Summary statistics include the mean, the minimum, the maximum, the standard deviation, the Skewness and the Kurtosis for the period 1998-2002.

Table 5

Descriptive statistics of the explanatory variables

The sample contains 99 German firms listed on the Deutsch Boerse for which we have a minimum of four consecutive years of data for the period 1998-2002.

	PROF	**SIZE**	**TANG**	**NDTS**	**GROW**	**RISK**
Mean	-0.062	18.289	0.176	0.0627	1.769	0.067
Maximum	0.546	21.960	2.921	1.769	399.513	5.080
Minimum	-2.300	12.550	-0.282	0.000	-0.998	1.44E-07
Std. Dev.	0.262	1.364	0.249	0.121	18.703	0.336
Skewness	-3.819	-0.266	5.861	9.790	20.375	10.397
Kurtosis	23.994	3.472	51.910	124.314	432.538	131.054
Observations	476	476	476	476	475	477
Cross sections	99	99	99	99	99	99

In this descriptive table, we can see that profitability (PROF) and size (SIZE) have an asymmetric distribution to the left, while all the rest of proxy variables are asymmetric to the right. On the other hand, all variables show strong leptokurtosis.

5 Model specification and diagnostic tests

Having discuss the variables that determine the optimal capital structure and variable that is used as measure of leverage in the previous section, we will now specify panel data models used in our study.

Let us consider the simple linear model in a static level :

$$y_{it} = \gamma_i + x_{1it}\beta_1 + x_{2it}\beta_2 + ... + x_{kit}\beta_k + \mu_{it} \; ; \quad i = 1, ..., N \; and \; t = 1, ..., T \tag{1}$$

or, compactly

$$y_{it} = \gamma_i + \beta^{'} x_{it} + \mu_{it} \tag{2}$$

where i = 1,.,N and t=1,.,T

and y_{it} : leverage of firm i in year t

x_{it} : a vector of 6 time-varying regressors $(x_{1it}, x_{2it}, ..., x_{6it})$ assumed to be strictly uncorrelated with past, present and future realization of μ_{it}

$b^{'}$: a 6 x 1 vector of constants $(b_1, b_2, ..., b_6)$

γ_i : individual effects or an unobserved heterogeneity

μ_{it} : error term $(\mu_{i1}, \mu_{i2}, ..., \mu_{iT})$ independently and identically distributed with zero mean and variance σ^2_μ

Prior researches predict that in a perfect world, without transaction and adjustment costs, companies would automatically respond to any variation of their debt objective by increasing or decreasing the capital.

So, under ideal conditions, the observed leverage of firm i at time t (y_{it}), should not be different from the optimal leverage, $y^*_{it} = y_{it}$. In a dynamic setting, this implies that the change in actual leverage from the previous to the current period should be exactly equal to the change required for the firm to be at optimal at time t, $y_{it} - y_{it-1} = y^*_{it} - y_{it-1}$. However, if adjustments are costly, then firms may not find it optimal to adjust fully, or they would only adjust partially. This process can be represented using the following partial adjustment model,

$$y_{it} - y_{it-1} = \lambda(y_{it}^{*} - y_{it-1}) \tag{3}$$

Where y_{it}^{*} is the target Leverage ratio estimated from equation (2), and λ is the adjustment parameter : If λ =1, then the entire adjustment is made within one period and the firm at time t is at its target leverage. If λ <1, then the adjustment from year t-1 to t falls short of the adjustment required to attain the target. If λ>1, the firm over-adjusts in the sense that it makes more adjustment than is necessary and is still not at the optimal.

Once developed , equation (3) can be rewritten as :

$$y_{it} = (1 - \lambda)y_{ti-1} + \lambda y_{it}^{*} \tag{4}$$

λ can also be seen as a speed of adjustment, and in this way a high value for λ indicates quicker adjustment.

The estimation of the previous model can be undertaken with a tow stage regression analysis. As a target leverage is not directly observed, the first stage consists of a regression analysis described for the static model. We pose that for company i, in moment t, leverage is given by :

$$y_{it}^{*} = \gamma_i + b^{'} x_{it} + \mu_{it} \tag{5}$$

In the second stage, the adjusted values in the regression (5) are taken as a proxy of the target leverage in the estimation of the equation (4).

In this way, substituting (4) and (5) and reorganizing the terms of the resulting equation as follow:

$$y_{it} - y_{it-1} = \lambda\left[\left(\gamma_i + b^{'} x_{it} + \mu_{it}\right) - y_{it-1}\right] \tag{6}$$

$$y_{it} = \lambda\gamma_i + \lambda b^{'} x_{it} + \lambda\mu_{it} - \lambda y_{it-1} + y_{it-1} \tag{7}$$

we obtain

$$y_{it} = \lambda b^{'} x_{it} + (1 - \lambda)\, y_{it-1} + \lambda\gamma_i + \lambda\mu_{it} \tag{8}$$

By simplifying the least equation we arrive at :

$$y_{it} = \pi_i + \psi y_{it-1} + \beta^{'} x_{it} + \varepsilon_{it} \tag{9}$$

with $\pi_i = \lambda\gamma_i$; $\psi = (1-\lambda)$; $\beta^{'} = \lambda b^{'}$ and $\varepsilon_{it} = \lambda\mu_{it}$

Whether to treat the effects as fixed or random is not an easy question to answer. However, it can make a big difference in the estimates of the parameters.

The salient distinction between the two models is whether the time-invariant effects, γ_i , are correlated with the regressors or not. The random effects assumes that they are uncorrelated, while the fixed effects estimator allows them to be correlated.

In this case, the character of the individual effects is tested through the Hausman's specification test (Hausman, 1978), that is usually employed over the null hypothesis that the individual effects are not correlated with the explanatory variables.

However, to obtain consistent estimates, the individual effects have to be dealt with first. The most common approach is to transform the original equation to remove the individual specific effects. This eliminates the problem of correlation between the lagged dependent variable and the individual specific component. Since the individual specific effects are removed, it does not matter whether we conceive of them fixed or random in the original model. However, these transformations create a different kind of correlation between the lagged endogenous variable LEV_{it-1} and the error term ε_{it}. Instrumental variables are then employed to eliminate this problem.

Anderson and Hsiao (1982) suggest the first difference estimators as a specific estimator of the dynamic panel model. Using a Two Stage Least Square (2SLS) estimation procedure, the idea is to first-difference equation (9) that gives:

$$y_{it} - y_{it-1} = \psi(y_{it-1} - y_{it-2}) + \beta^{'}(x_{it} - x_{it-1}) + \varepsilon_{it} - \varepsilon_{it-1} \tag{10}$$

Anderson and Hsiao proposed two instrumental variable estimators that are consistent: instruments in differences (Δy_{it-2}) and instruments in levels (y_{it-2}).

In our analysis we simply use y_{it-2} as an instrument. The choice of instruments in levels is based on Arellano (1989), he shows that the estimator that uses differences as instruments suffer from singularities as well as large variance over a range of values for ψ. Thus the estimator that uses instruments in levels is preferred to the one that uses instruments in differences.

6 Empirical analysis and results

From panel data of 99 new high-tech German firms sample, covering the five year period 1998-2002, we have tested some hypothesis of theoretical capital structure.

The panel character of our data allows us to use panel data methodology for testing our model discussed above, simultaneously combining cross section and time series data. Panel models are classified into dynamic and static models, depending on whether the lagged dependent variable is included, or not, in these models. Each kind of model needs a different estimation technique in order to achieve efficient and consistent estimators. In this paper we are interested only in the dynamic model, but we briefly explain the Hausman test for Random versus Fixed Effects in the static level.

To deal with the problem of heteroskedasticity and serial correlation, we select an appropriate model by testing Random versus Fixed Effects models.

To perform this comparison, the character of the individual effects is tested through the Hausman's specification test which is described above under :

$$H_0 : cov(\gamma_i, x_{it}) = 0$$

Our results for this test are reported in the following table:

Table 6

Hausman test for Fixed versus Random effects			
Null hypothesis	$H_0 : cov(\gamma_i, x_{it}) = 0$	**Test statistic**	h~$\chi^2(6)$
Critical value	$\chi^{2*}(6)$ =16,812		h =38,510457
Decision	h > $\chi^{2*}(6)$ Reject H0		
Conclusion	The individual effects are supposed to be Fixed		

This procedure indicates that the individual effects are supposed to be Fixed. Thus the WG estimators (Fixed effects model) are more efficient relative to the GLS estimators (Random effects model) under H_0.

One way to handle the problem posed by the static model, is to estimate the dynamic panel data models. Dynamic panel data models include as part of their specification both lagged dependent variables and unobserved individual specific effects. These models are very powerful tools that allow for empirical modeling of dynamics while accounting for individual level heterogeneity. Because dynamic panel models explicitly include variable to account for past behavior and time invariant individual specific effects, they enable us to understand better what factors drive behavior over time, differentiating between true dynamics and factors that vary across, but not within, individuals over time. However, we must be careful when choosing from among the various dynamic panel estimators that are available.

Because we need to check that the disturbance, ε , has the properties we assume for it (no serial correlation), we will in particular test for serial correlation using an LM test. It analyzes how well the lagged residuals explain the residuals of the original equation (9). If the lagged residuals do significantly well in explaining the residuals then we can conclude that there is serial correlation.

In table 7 we present various dynamic estimations of the determinants of leverage. All coefficients are estimated using White's (1980) heteroskedasticity consistent variance-covariance matrix estimator. Results are reported for Pooled OLS, Within Group and GLS estimators. Standard errors are in parentheses. All the estimations have been undertaken by the statistical software Eviews 4.0. ***/**/* denotes significance at the 1% ; 5% and 10% level. LM test is a test of the serial correlation, it is asymptotically distributed as χ^2 under the null hypothesis of no serial correlation.

Table 7

Dynamic results

	POLS	**Fixed effects(WG)**	**Random effects(GLS)**
LEV_{it-1}	0.2806	0.0787	0.1321
	$(0.107)^{**}$	$(0.021)^{***}$	$(0.195)^{***}$
SIZE	0.0164	0.0587	0.0752
	$(0.002)^{**}$	$(0.023)^{**}$	$(0.010)^{***}$
PROF	-0.0473	-0.3930	-0.2854
	(0.059)	$(0.064)^{***}$	$(0.053)^{***}$
TANG	0.0660	-0.0495	-0.0082
	$(0.063)^{**}$	(0.038)	(0.031)
NDTS	0.3512	0.0700	0.1799
	$(0.116)^{**}$	(0.084)	(0.091)
RISK	-0.1243	-0.1708	-0.1628
	$(0.051)^{*}$	$(0.042)^{**}$	$(0.041)^{**}$
GROW	-0.0013	-0.0003	-0.0006
	(0.002)	$(0.001)^{*}$	$(0.003)^{*}$
R^2	0.2047	0.6201	0.5083
LM test	118.42	5.28	31.97

The results for Pooled OLS, Within Group and GLS estimators and for the LM test reported in table 7 show that there is serial correlation at the 95% confidence level, since the calculated LM test statistic (respectively 118.42, 5.28 and 31.97) exceeded the critical $\chi^2(1)$ value (3.84). Therefore, these estimators for dynamic panel model almost yields biased estimates due to the violation of the assumption of independent errors, as long as the estimations seem to be inconsistent with the classical assumptions.

To obtain consistent estimates in the dynamic level, we report Anderson and Hsiao Estimator.

Below, table 8 reports the results obtained for the dynamic panel data model with The Anderson and Hsiao estimator that provides 2SLS estimations of the model in its first differences structure.

Table 8

Anderson and Hsiao results for the dynamic panel data model

*Standard errors are in parentheses. All the estimations have been undertaken by the statistical software Eviews 4.0. ***/**/* denotes significance at the 1% ; 5% and 10% level. Wald test is a test of the joint significance of the estimated coefficients, it is asymptotically distributed as $\chi^2(7)$ under the null hypothesis of no relationship.*

	Anderson and Hsiao Estimates		
		Coefficients	**Std.error**
LEV_{it-1}		0.0420	0.024^{**}
SIZE		0.0486	0.019^{***}
PROF		-0.2983	0.071^{***}
TANG		0.0434	0.041^{*}
NDTS		0.1349	0.110^{**}
RISK		-0.1233	0.050^{***}
GROW		-0.0002	0.003
R^2	0.875		
Adjusted R^2	0.864		
Wald test (7)	32.80		

In the dynamic capital structure model, the most powerful estimation technique employed is Two Stage Least Squares in first differences with Anderson and Hsiao's estimator. Instrumental variables techniques, such as the ones described above, enable us to control the endogeneity problems shows by certain explanatory variables.

The empirical evidence obtained indicates that the sample of German Firms, taken in our study, have a target or optimum leverage ratio, which is explained as a function of some specific characteristics of the firm.

Specifically, the estimated value of the parameter associated to the lagged leverage ($\psi = 1-\lambda$) turned out to be 0.0420, which indicates that the adjustment parameter would be approximately 0.958. The high value of this adjustment coefficient denotes the high adjustment speed of German firms which is very close to the target leverage. Moreover, the adjustment process is a trade off between the adjustment costs toward a target ratio and the costs of being in disequilibrium. If the costs of being in disequilibrium are greater than the adjustment costs, then the estimated coefficient should be close to zero. In the contrary case, the estimated coefficient should be close to one. Thus, for German firms the adjustment costs are greater than costs of being in disequilibrium.

As suggested by Rajan and Zingales (1995), our results show a negative and statistically insignificant relation between growth opportunities and the level of leverage ($\hat{\beta}_{GROW} = -0.0002$). It is generally acknowledged that the associated agency costs are higher for firms with substantial growth opportunities. Thus, our results verify the prediction of the trade-off model that firms with more investment opportunities have less leverage because they have stronger incentives to avoid underinvestment and asset substitution that can arise from stockholder-bondholder agency conflicts. This prediction is strengthened by our results for German firms. We can say that for this sample, firms with more investment opportunities have less need for the disciplining effect of debt payments to control free cash flow.

Results in table 8 illustrate the idea that as a general rule, large companies tend to use more debt than smaller companies ($\hat{\beta}_{SIZE} = 0.0486$) . Nonetheless, our results suggest that the correlation between size and leverage level may have strengthened. This result is the same as that obtained by a considerable number of previous studies. The explanation of this relationship could come from the fact that small companies have to face higher bankruptcy costs, greater agency costs and bigger costs to resolve the higher informational asymmetries. Consequently, firms of greater size can access a higher leverage and banks are more willing to lend to large companies.

Our previous results illustrate that the most significant coefficient in regression relate to the impact of profitability on capital structure. Thus, leverage is negatively correlated with the level of profitability ($\hat{\beta}_{PROF} = -0.2983$). While profitable firms may have better access to debt finance than less profitable firms, the need for debt finance may possibly be lower for highly profitable firms if retained earnings are sufficient to fund new investments.

The results of our panel study found that tangibility tends to positively correlated with leverage in our sample ($\hat{\beta}_{TANG} = 0.0434$). This relationship argues that stockholder of levered firms are prone to overinvest, which gives rise to the classical shareholder-bondholder conflicts. Hence, the trade-off theory that predicts a positive relationship between measure of leverage and the proportion of tangible assets is validated for our sample.

A negative relation between operating risk and leverage is expected from a pecking order theory perspective: firms with high volatility of results try to accumulate cash during good years, to avoid under investment issues in the future. Accordingly, results given by our sample suggest a negative correlation ($\hat{\beta}_{RISK} = -0.1233$).

Firms will exploit the tax deductibility of interest to reduce their tax bill. Therefore, firms with other tax shields, such as depreciation deductions, will have less need to exploit the debt tax shield. In other words, the incentive to use debt financing diminishes as non-debt tax shields increase. Accordingly, in the framework of the trade-off theory, one hypothesizes a negative relationship between leverage and non-debt tax shields. In contrast, our results argue for a positive relationship between leverage and non-debt shield ($\hat{\beta}_{NDTS} = 0.1349$). Hence, firms with substantial non-debt tax shields should have considerable collateral assets which can be used to secure debt.

7 Conclusion

This research presents a study of dynamics of the capital structure from a sample of German companies. The analyses are performed using data pertaining to 99 new high-tech German firms between 1998 and 2002.

Dynamic specifications are of particular interest in modelling panel data, part of the richness of a panel data set is precisely due to the fact that we can analyze the process of dynamic adjustment which is impossible in a cross section data set. First, we used the within-groups and the GLS estimators, but we found that estimations are biased even for large N when T is small. Alternatively, Anderson and Hsiao (1981) proposed a consistent estimator which is an instrumental variables estimator for the first differenced equations. This is a specific estimators of the dynamic panel model, using a Two Stage Least Square (2SLS) estimation procedure.

Considering the results of the most powerful estimation (Anderson and Hsiao) as our reference, the empirical evidences obtained for capital structure from new high-tech German firmsare stable and similar to those documented in the previous empirical researches. The results clearly indicate the existence of an optimal debt level, this verify the prediction of the trade off theory. The evidence seems to confirm that new high-tech German firms adjust their target ratio very quickly. Our parameter for adjustment speed, λ, was 0.958. This coefficient is clearly higher than that found by Rajan and Zingales.

Confirming the pecking order model but contradicting the trade off model, we find that more profitable firms use less leverage. We also find that large companies tend to use more debt than smaller companies, and that firms which have high operating risk can lower the volatility of the net profit by reducing the level of debt. Using a simple target adjustment model, we report evidence that firms adjust to their targets quickly. Finally, we find that Leverage is also closely related to tangibility of assets and to the ratio of non-debt shield.

Our results are robust to several alternative estimation techniques, and while they depend on the exact definition of leverage, they are similar to what has been previously reported.

In general term, both theoretical approaches, the pecking order and the trade off theories, appear to help explain the financial behavior of new high-tech German firms. However, given the nature of their activity, there is an implied suggestion that no ideal capital structure exists for these firms.

Thus, from an empirical perspective, emphasis should be placed on constructing dynamic models that enable us to describe the financial behavior of new high-tech firms with discrimination between the various factors that impact on the target and those that impact on the speed of adjustment of these firms. Nonetheless, in so doing we raise several future avenues of research which may hopefully allow more concrete conclusions to be drown such as the more complete analysis of capital structure choice in new high-tech firms, with the development of a new capital structure theory into an empirical model to describe the financial behavior of new high-tech firms.

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