Empirical Capital Structure Research: New Ideas, Recent Evidence, and Methodological Issues

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Abstract

Even 50 years after Modigliani/Miller's irrelevance theorem, the basic question of how firms choose their capital structure remains unclear. This survey paper aims at summarizing and discussing corresponding recent developments in empirical capital structure research, which, in our view, are promising for future research.

We first present some "stylized facts" on capital structure issues. The focus of the discussion is set on studies taking on the key idea to differentiate between competing theories by testing for firm adjustment behavior following shocks to their capital structure. In addition, we discuss empirical studies examining additional factors that may influence capital structure decisions, but have gained only recently attention in the literature (like corporate ratings or irrational managers).

Since some of the available contradictory evidence on capital structure issues might be explained by econometric challenges due to the typical data structure, we also discuss methodological issues like panel data, endogeneity, and partial adjustment models in the capital structure context.

Finally, we illustrate the methodological and empirical aspects discussed in this survey by providing corresponding evidence for exchange-listed German companies in the period 1987-2006.

JEL Classification: G32

Keywords: Corporate finance, capital structure determinants, dynamic adjustment models.

A. Introduction

„How do firms choose their capital structure? ... We don‘t know.“

(Stewart Myers, Presidential Address AFA, Myers 1984, p. 575)

How do firms finance their investments? How does financing interact with investment? And, most generally, do financing decisions affect firm value? These essential questions in corporate finance are still contended, and the theoretical and empirical literature is far from reaching consensus even on some of the most basic issues. Therefore, 50 years after the seminal Modigliani/Miller (1958) paper, Stewart Myers' quote is still valid, but there have been gained some insights in recent years. This survey paper aims at summarizing and discussing corresponding recent developments in empirical capital structure research.

In the light of the vast literature on capital structure issues, we do not try to provide a comprehensive review, and we do not discuss theory in detail.[1] Rather, as a starting ground, we will give a brief outline of the major theoretical ideas and the corresponding empirical implications, and present some "stylized facts" on capital structure issues. The focus of our discussion is on (subjectively) selected recent empirical studies. In particular, our selection of studies is based on Myers' (1984) insight, that the key question to differentiate between competing capital structure theories is whether firms adjust to some target following shocks to their capital structure. This is due to the fact, that trade-off theories suggest that firms try to maintain some "optimal" debt ratio, while e.g. pecking order or market-timing theories suggest that there is no target level of leverage.

Correspondingly, we discuss the study by Welch (2004), who examines adjustment behavior following shocks to the market-value based debt ratio due to changes in the equity value of companies, the study by Flannery/Rangan (2006), which takes dynamic adjustment behavior of firms explicitly into account in the design of the empirical model, and the studies by Mayer/Sussman (2005) and Elsas et al. (2007), which examine dynamic financing patterns, when firms undertake very large investments. Also, we briefly address studies that focus on shocks from macroeconomic factors and the competitive and regulatory environment.

We complement our review of studies on firms' adjustment behavior to capital structure shocks by discussing additional factors that may influence capital structure decisions, but

have gained only recently attention in the literature. For instance, Kisgen (2006) considers for the first time the role of ratings from external rating agencies (like S&P or Moody's) in the capital structure context. This seems an important contribution due to the eminent role that rating agencies play in capital markets nowadays. Finally, our review of further potential determinants of capital structure is completed by looking at recent studies that consider irrational behavior of economic agents (in particular firm managers) as a potentially important determinant of capital structure. This idea is exemplified by the studies of Malmendier et al. (2007) and Ben-David et al. (2007), which analyze the consequences of managerial overconfidence empirically.

Another major part of this survey is concerned with the econometrics of capital structure research. There are three major econometric issues that make explaining systematic variation in corporate leverage a formidable task (Welch 2007): i) the panel nature of the data, ii) endogeneity between the capital structure and potential determinants (i.e. explanatory variables in a regression context), and iii) dynamic adjustment of leverage. These problems may lead to severe biases of standard econometric estimators in the capital structure analysis context, which in turn might help explaining parts of the contradictory evidence in leverage determinants in the literature. We will discuss these issues in more detail, emphasizing the need to take them into account carefully in an empirical design. This seems highly relevant because (too) often these issues are ignored. For instance, the Fama/MacBeth (1973) regression approach is frequently used by researchers in the capital structure context. But this method fails to adjust inference for the main econometric issue in using panel data, the correlation of observations from one firm (individual) over time (see Petersen 2007).

Also, the adjustment of leverage to a target level after the occurrence of shocks necessarily takes time. This makes the challenges from the panel nature of the data even more complex, since standard panel estimators like the fixed effects-model are severely biased within a dynamic panel structure (Arellano/Bond 1991). The econometric issue of how to estimate speeds of adjustment using panel data is of course a major obstacle for studies analyzing dynamic capital structure issues. The corresponding methodological discussion thus complements our review of Flannery/Rangan (2006) and related studies, which tackle dynamic adjustments in applied studies.

Finally, in order to illustrate the relevance of the methodological and empirical issues addressed in the survey, we conduct an analysis of capital structure determinants of German

exchange listed firms for the period 1987-2006. This serves to make the concepts and ideas more transparent, and helps demonstrating the impact of modeling choices using an integrated and concrete example throughout the discussion.

Putting all together, the survey is structured as follows. In Section B, we briefly discuss fundamental theoretical ideas and stylized facts of previous empirical capital structure research. Important econometric issues like endogeneity and the panel structure of the data are discussed in Section C. Empirical studies that focus on firms' adjustment behavior, or suggest additional capital structure determinants, will be discussed in Section D. The empirical illustration using the German firm sample is presented throughout all discussions, details on the data are provided in the Appendix. Section E concludes.

B. Fundamental Ideas in Capital Structure Research and Stylized Facts

I. Fundamental Ideas in Capital Structure Research

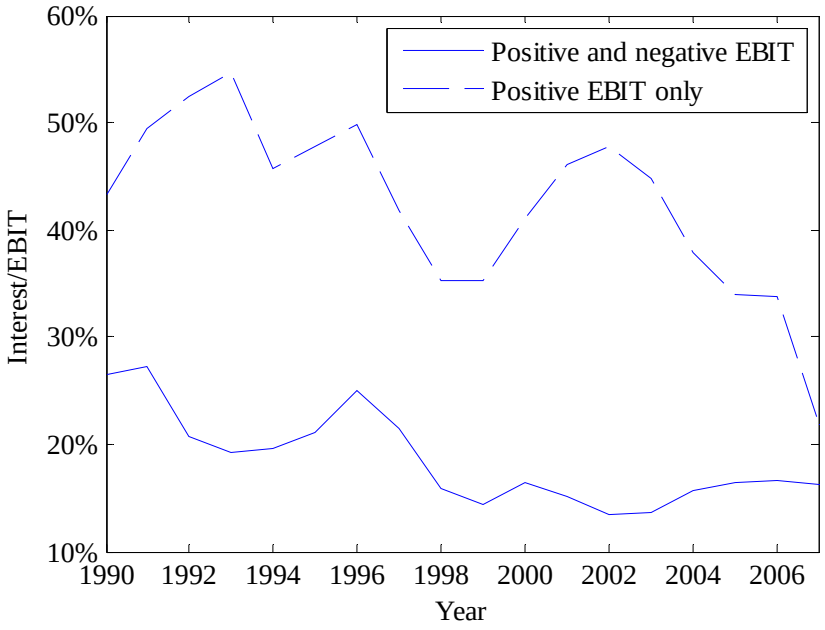
Showing the irrelevance of capital structure decisions for firm value in perfect capital markets, Modigliani/Miller (1958) have defined the reference point for all theoretical discussions. Their no-arbitrage result suggests that observed firm capital structures should not entail systematic patterns of within-group homogeneity and between-group heterogeneity. However, these patterns, like industry-specific leverage ratios, are observable within and across financial systems, implying the relevance of capital market imperfections.

At the same time, patterns like industry-specific leverage render simple (but nevertheless for companies important) tax-based explanations for capital structure patterns insufficient. Under most international tax-regimes, debt financing is advantageous for companies, because interest payments can, to some extent, reduce firms' tax burden, while payments to equity holders cannot. This different treatment of equity and debt leads to the so-called tax-shield of debt financing, constituting a strong argument in favor of debt. However, tax-based explanations are from an economic perspective a somewhat unsatisfactory capital structure determinant, because taxes are set exogenously by governments, without a clear underlying economic rationale. Moreover, since corporate tax-regimes typically are homogenous for companies located in the same country at the same time, taxes cannot explain fully the observed systematic capital structure heterogeneity (Graham 2003).

To illustrate that the tax-advantage of debt financing does not suffice to explain observed financing patterns, Fig. 1 shows the yearly average of German firms' interest expenditures as a percentage of Earnings before Interest and Taxes (EBIT), which is an approximation for the taxable income of firms. Ignoring that interest payments may not be the only possibility for companies to reduce tax payments, the maximum tax benefit of leverage is exploited, if firms' interest expenditures correspond to the expected EBIT per period. However, Fig. 1 clearly illustrates for our German sample that firms do by far not exploit their potential tax benefit.[2] The average interest to EBIT ratio (solid line) is constantly below 30% over the observation period from 1987-2006. There is even a tendency to decrease the interest to EBIT ratio. The same pattern holds if one excludes firm-year observations with a negative EBIT ratio. In this case (dashed line), the ratio is always below 55%. This strongly suggests that taxes cannot be the only determinant of optimal leverage (also see Rajan/Zingales 1995 and Graham 2000).

Fig. 1: Yearly averages of interest payments as a percentage of EBIT for German firms, 1990-2007

The figure shows yearly averages of interest payments as a percentage of positive and negative EBIT and positive EBIT only for German firms, 1990-2007. The sample is described in detail in the Appendix.

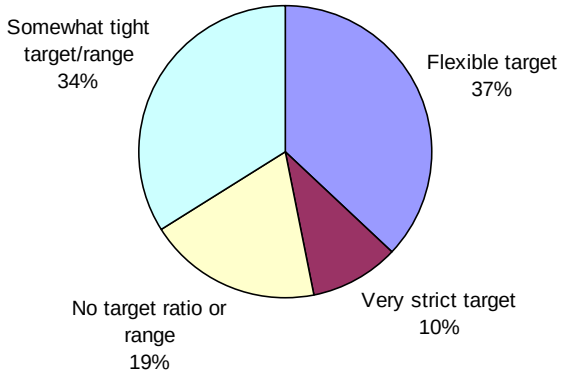


Moreover, firms (or their managers) themselves do not believe in the irrelevance of capital structure. The Graham/Harvey (2001) survey of 392 CFOs of U.S. firms illustrates that the majority of firm managers consider capital structure decisions important for firm value and that firms have some target debt-equity ratio (see Brounen et al. (2006) for a corresponding

survey of German manager views). As can be seen from Fig. 2, Graham/Harvey (2001) report that 81% of the questioned CFOs answered that they do have some target debt ratio or range.

Fig. 2: Graham/Harvey (2001) results

Graham/Harvey (2001) survey 392 CFOs of U.S. firms. The pie chart visualizes the answers to the question, whether the polled CFOs have some target debt ratio or range.



These observable patterns in actual firm capital structures suggest that capital markets are imperfect in reality, requiring theories of capital structure decisions based on (endogenous) market imperfections. The most influential and classical theories of capital structure taking capital market imperfections into account are the trade-off and the pecking order theory. In the trade-off theory firms find to their optimal leverage by balancing the costs and benefits of different financing sources. The classic, so-called ”static” trade-off theory (Kraus/Litzenberger 1973, Myers 1984) considers only costs and benefits of debt, in particular tax savings versus (expected) deadweight costs of bankruptcy. Quite generally, however, trading off costs and benefits of different available sources of financing (i.e. not only debt) is an essential economic principle, such that the trade-off theory is understood in this broader sense in this paper. If the resulting “optimal” or target leverage varies over time (due to time-varying determinants), this is labeled the dynamic trade-off theory. As emphasized by Myers (1984), the main empirical implication of trade-off theories is that firms should adjust their capital structure to some target level if shocks to actual leverage occur, in line with Graham/Harvey’s (2001) survey evidence.

The pecking order theory mainly due to Myers/Majluf (1984) and Myers (1984) holds that firms generally prefer inside to outside financing, i.e. cash flows from firm operations to debt,

and equity as a last financing resort. The underlying rationale is most often derived from problems of asymmetric information among a company's stakeholders, i.e. problems of adverse-selection or moral hazard (see e.g. Frank/Goyal (2008) and Neus/Walter (2008) in this volume). Such a preference order on financing sources suggests empirically that firms should follow their preferences regardless of shocks. Hence, the existence of adjustment behavior allows for discriminating between trade-off and pecking order theories, rendering tests for adjustment behavior probably the most fruitful and important approach in designing empirical tests of capital structure issues.

Two other theoretical ideas that compete with trade-off and pecking order theories are behavioral finance and the so-called market-timing explanations. In behavioral finance theories, agents (in particular managers) behave irrationally, e.g. being overconfident or optimistic. Interestingly, opposed to the pecking order idea, the availability of free cash flow is in this framework often instrumental for inefficiencies. For example, if managers are overconfident, the theory predicts that they will invest in projects that appear beneficial to them but are costly to shareholders (e.g. due to a negative net present value). Regarding the implications, this is similar to the implications of the free cash flow problem due to "empire building" managers (Jensen 1986) and the "managerial hubris" hypothesis of Roll (1986). All these ideas suggest that managers will have a tendency to hold cash excessively, because with having free cash flow they are not subject to the scrutiny of external investors. However, the similarity in theoretical predictions makes it at the same time a challenge to differentiate between these arguments empirically.

The market-timing explanation states that firms issue equity, when market prices are (irrationally) overpriced, using the corresponding "window of opportunity" (Baker/Wurgler 2002, Ritter 1991). Similar to pecking order theories, market timing implies that there is no adjustment to some target leverage if shocks occur. Rather, a firm's leverage then reflects the pattern of historical security mis-pricings at times, where new investments needed to be financed.

II. Stylized Facts

Most empirical studies on capital structure determinants build on a list of variables likely to affect capital structure choices suggested by Harris/Raviv (1991) in their theory review: fixed assets, non-debt tax shields, investment opportunities, firm size, earnings volatility, default risk, profitability, advertising expenditures, R&D expenditures, and product uniqueness. Har-

ris/Raviv (1991, p. 334) even suggest that available studies "generally agree" on these determinants, although already the classic paper by Titman/Wessels (1988) finds no significant impact of non-debt tax-shields, volatility, collateral value, or future growth on debt ratios. This pattern of ambiguous and in part contradictory evidence can be traced through the empirical literature ever since Modigliani/Miller (1958). Still, the recent evidence has at least reached consensus on some variables and financing patterns that appear sufficiently robust empirically. These variables will be discussed in the following as "stylized facts".

In their seminal empirical study, Rajan/Zingales (1995) examine the determinants of capital structure choices in major industrialized countries. Overall, the authors find corporate leverage and its determinants in the G-7 countries to be fairly similar. Their evidence serves as a starting point for variable selection in empirical studies since, comprising the factors growth, profitability, tangibility and size. Frank/Goyal (2007) suggest that using only these factors and omitting expected inflation and the median industry debt ratio leads to misspecifications, rendering other factors statistically insignificant or changing their signs. In their study based on COMPUSTAT data for U.S. firms for the period 1950 to 2003, the authors identify several cross-sectional factors of leverage that are "reliably important". They provide a list of 25 variables from prior literature and find that six core variables are able to robustly explain 27 % of cross-sectional variation in leverage. The remaining 19 determinants explain only further 2 % of the variation.[3]

The following overview summarizes these "core" determinants of capital structure and their theoretically predicted effect on leverage by classic capital structure theories, based upon the findings of Frank/Goyal (2007):

a. Growth (-)

Growth or growth opportunities are most often measured by Tobin's Q (with the market-to-book ratio of equity and/or assets serving as the empirical proxy). Growth has been found to be negatively correlated with leverage. In a similar study, Shyam-Sunder/Myers (1999) draw the same conclusion. Barclay et al. (2006) provide more distinguished results, concentrating on debt capacity and growth options.

This empirical evidence is consistent with the theoretical prediction of the trade-off theory, because the availability of growth opportunities might increase expected costs of financial

distress, resulting in lower leverage. On the other hand, current and future growth must arise from (real) investments, which should be financed with more debt according to the pecking order theory. Thus, the negative relation between leverage and growth is not consistent with the pecking order theory.

b. Size (+)

Typical measures of firm size are the logarithm of assets or the age of firms, where mature firms tend to be larger than immature firms. In most cross-sectional tests, size and leverage are positively correlated. Evidence from dynamic trade-off studies also supports that size is positively related to leverage.

This result is consistent with the prediction of the trade-off theory, because larger or more mature firms are likely to have lower default risk, and are less opaque than smaller firms due to their established track record of success and the attention received from analysts and rating agencies (thus reducing informational asymmetries). These arguments imply a potential for higher leverage. According to the pecking order theory, the prediction on the size-leverage relationship is not clear due to the ambiguous impact of a reduced degree of asymmetric information on the relative agency costs of cash versus debt versus equity.

c. Tangibility (+)

Tangibility of assets is most often measured by the ratio of fixed assets to total assets. The relationship between tangibility and leverage has been found to be positive in most cases. Tangibility is also positively related to leverage as a control variable in dynamic trade-off analyses.

This evidence is consistent with the trade-off theory, if tangible assets serve as collateral for debt financing, thereby reducing costs of financial distress and increasing the debt capacity of firms. However, a positive relationship between available tangible assets and leverage is consistent with the pecking order theory as well, if collateral reduces the relevance of asymmetric information, thereby making the preference order less strict.

d. Profitability (-)

The relation between profitability of firms and leverage is quite generally found to be significantly negative in studies of the cross-section of debt ratios. Kayhan/Titman (2007) also find this relation in their analysis of changes in debt ratios, but the effect is relatively weak. In dynamic trade-off studies, profitability is also clearly negatively related to leverage. As already mentioned, the financing behavior of firms is likely to change over time. For example, Frank/Goyal (2007) find that profitability has lost some of its explanatory power for U.S. firms' capital structures over the last decades.

If higher profitability decreased the expected costs of financial distress (assuming some stationarity of profitability), one would expect to find profitability to increase leverage under the trade-off theory. Also, since higher profitability will translate into more free cash flow, debt should be more valuable due to its disciplining effect on managers. Thus, the finding of a negative relationship is more consistent with the pecking order theory, because higher cash flows ceteris paribus reduce the necessity to issue debt.

e. Industry Median Debt Ratios (+)

The industry median leverage has been found to have high explanatory power and is most often positively correlated with leverage. This seems obvious in univariate analysis, but in a multivariate context the median leverage should not anymore affect leverage, because one controls for the determinants of capital structure simultaneously. To explain the explanatory power, Frank/Goyal (2007) assert that managers use industry median leverage as a benchmark within the industry or some sort of target capital structure to which they adjust (e.g. Hovakimian et al. (2001) find that firms adjust to the industry median leverage). Alternatively, the relationship might be explained by industry median leverage accounting for omitted factors common to the industry, such as product market interactions or the nature of competition. Furthermore, MacKay/Phillips (2005) suggest that firms' operational leverage relative to the industry median and the industries' degree of competition are important determinants of capital structures as well.

f. Expected Inflation (+)

There is cross-sectional evidence that the relationship between expected inflation and leverage is positive. Among the six core factors suggested by Frank/Goyal (2007), expected inflation is

probably the least reliable due to estimation based upon the difficulty to observe expectations in general and the low frequency of observations for macroeconomic data.

In their survey article, Frank/Goyal (2008) identify additional stylized facts in empirical capital structure research. These include, among others, further facts about financing decisions at the aggregate level. For instance, over long periods of time, leverage of U.S. firms at the aggregate level has been found to be stationary with the aggregate market-based leverage ratio of 0.32. Also, market conditions have some impact on corporate financing decisions. For instance, Baker/Wurgler (2002) find that firms time the market, which means they issue equity when market conditions are good and repurchase equity when market conditions are bad. Hovakimian et al. (2001) find that firms tend to issue equity following a stock-price run-up. However, to which extent market conditions can explain capital structure is contended in the literature, mostly because these results are challenged on econometric grounds (see e.g. Hovakimian (2004) and Kayhan/Titman (2007)).

III. Stylized Facts for German Exchange Listed Firms

In order to illustrate the relationship between the "core" determinants discussed in the preceding section and firm leverage, Tab. 1 summarizes the results of ordinary least squares (OLS, fourth column) and fixed effects regressions (fifth column) for non-financial German firms in the period from 1987 to 2006.[4] In both models, the market-value-based debt ratio is regressed on a set of explanatory variables that have been used by Rajan/Zingales (1995). Also, in both models dummy variables for the year of the observation are included (omitting one year to avoid collinearity). The fixed-effects estimator includes a set of indicator variables (dummies) for all companies instead of the common intercept term.

In the table, all coefficient estimates are highly significant, independent of the method of estimation. Also, the year dummies are jointly significant in both regressions. Hence, time-variant factors that are common to all firms (like the interest rate level and other macro variables) systematically affect capital structure choices in Germany. In the fixed effects regression, the null hypothesis that all firm fixed effects are jointly equal to zero has to be rejected, indicating firm-specific but time invariant variables (like e.g. the industry affiliation) to be systematic determinants of capital structure choices for German exchange listed companies as well.

The signs of estimated coefficients for German firms generally correspond to the findings of Rajan/Zingales (1995), and Frank/Goyal (2007) for U.S. firms. Hence, the market debt ratio decreases in firm profitability and the market-to-book ratio as the proxy for firms' growth opportunities. The debt ratio increases in firm size and the availability of tangible assets to firms. An often cited finding by Rajan/Zingales (1995) is their negative estimate of the coefficient on firm size for German firms, while the authors report a positive relationship for all other countries. Our evidence shows that this finding for Germany is not robust, when using a larger sample and a panel of firm observations.

Tab. 1: OLS and fixed effects regressions for the Rajan/Zingales (1995) variables for German firms, 1987-2006

The dependent variable is market leverage. All regressor variables are lagged one year. Year dummies have been included. Sign RZ/FG is the sign of the coefficient estimate found in Rajan/Zingales (1995) and Frank/Goyal (2007) for the United States. Sign RZ DE is the sign of the coefficient estimate found in Rajan/Zingales (1995) for Germany. OLS standard errors are White heteroscedasticity-consistent standard errors. p-values are in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Regressors	Sign FG/RZ	Sign RZ DE	OLS Regression	Fixed Effects Regression
Constant			-0.289 (0.000)***	-0.458 (0.000)***
Profitability	[-]	[-]	-0.304 (0.000)***	-0.242 (0.000)***
Size	[+]	[-]	0.038 (0.000)***	0.051 (0.000)***
Market-to-Book	[-]	[-]	-0.014 (0.000)***	-0.007 (0.000)***
Tangibility	[+]	[+]	0.171 (0.000)***	0.113 (0.000)***
N			8802	8802
R-squared			0.283	0.247
F-test			141.57 (0.000)***	96.16 (0.000)***
F-test fixed effects			-	17.06 (0.000)***
F-test year dummies			20.91 (0.000)***	40.97 (0.000)***

Tab. 2 summarizes the results of OLS and fixed effects regressions for German firms, additionally including the core factors industry debt and expected inflation. The significance of the Rajan/Zingales (1995) factors does not change after the inclusion. The coefficient signs correspond to the findings by Frank/Goyal (2007), except for expected inflation in the fixed effects regression. The most important variables in terms of their magnitude are profitability and industry median debt.

Tab. 2: OLS and fixed effects regressions for the Frank/Goyal (2007) variables for German firms, 1987-2006

The dependent variable is market leverage. All regressor variables are lagged one year. Year dummies have been included. Sign FG is the sign of the coefficient estimate found in Frank/Goyal (2007). OLS standard errors are White heteroscedasticity-consistent standard errors. p-values are in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Regressors	Sign FG	OLS Regression	Baseline Model (Fixed Effects)
Constant		-0.345 (0.000)***	-0.493 (0.000)***
Profitability	[-]	-0.314 (0.000)***	-0.237 (0.000)***
Size	[+]	0.033 (0.000)***	0.050 (0.000)***
Market-to-Book	[-]	-0.013 (0.000)***	-0.007 (0.000)***
Tangibility	[+]	0.162 (0.000)***	0.112 (0.000)***
Industry Median Debt	[+]	0.334 (0.000)***	0.111 (0.000)***
Expected Inflation	[+]	0.006 (0.066)*	-0.007 (0.005)***
N		8802	8802
R-squared		0.305	0.259
F-test		160.59 (0.000)***	94.02 (0.000)***
F-test fixed effects		-	16.41 (0.000)***
F-test year dummies		24.65 (0.000)***	43.68 (0.000)***

As we will argue below, when analyzing capital structure issues using data that consist of a panel of firms repeatedly observed over time, controlling for unobservable time-invariant firm-specific effects is a minimum requirement to the applied econometric method. Therefore, the fixed effects regression shown in column 4 of Table 2 constitutes our baseline model throughout the paper, which can then be compared to the results of other methods and empirical designs we will discuss in the following sections.

C. Econometric Issues in Capital Structure Research

I. Panel Data

Very often, firm-specific variables such as book values of debt, size proxies, or profitability are observed as panel data, i.e. with a large number of observations in the cross-section (individuals) over short periods of time. Many studies do not adapt their econometric specifications to the panel nature of their data. This has two major drawbacks. First, the (additional)

information content of observing the same individual repeatedly is not fully exploited, and, second, drawn inferences may be flawed.[5]

The severity of this problem is illustrated by an exercise of Petersen (2007). He has searched a selection of the top finance journals for empirical studies using panel data in their analysis. Tab. 3 summarizes his findings on the applied methods to adjust standard errors for the panel nature in 207 papers.[6]

Tab. 3: Standard error adjustment in finance studies

Estimators and adjustment of standard errors in 207 studies relying on panel data and being published in top finance journals, as reported in Petersen (2007).

Estimation and Adjustment of Standard Errors	Percentage (%)
No adjustment	42
Adjustment	
Fama and MacBeth	34
Fixed Effects	29
OLS and White	23
OLS and Newey-West	7

Petersen (2007) finds that in 42% of the papers the standard errors have not been adjusted for any type of correlation in the error terms, i.e. completely ignoring the panel structure of the data. If standard errors were adjusted, the Fama/MacBeth (1973) procedure has been used most often, with a share of 34%. However, since this method only corrects for the panel nature of data in a very specific way (basically only correcting for time fixed effects), this popular choice of methodology can potentially affect the reliability of drawn inferences also in many studies of capital structure issues.

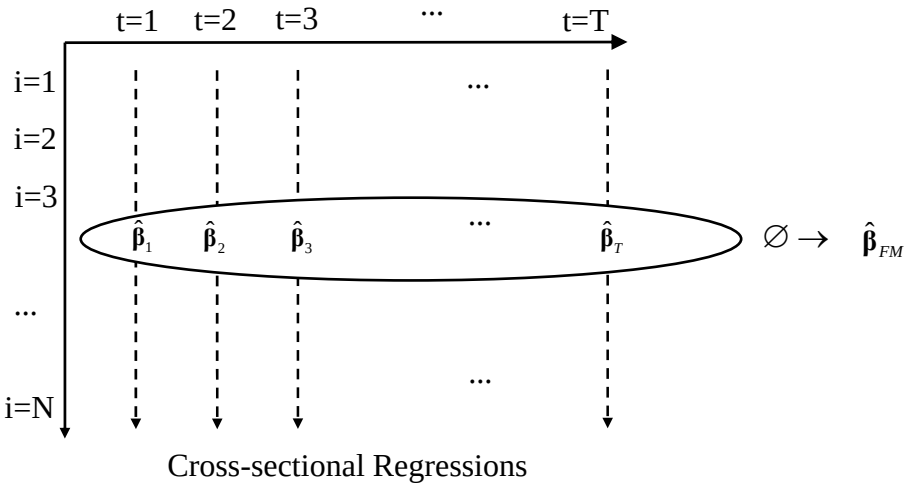
Originally, Fama/MacBeth (1973) have used their procedure to test implications of the CAPM empirically. In this procedure $(T x 1)$ returns $\mathbf{r}_i$ for each cross-sectional unit $i = 1,\ldots,N$ are regressed on some $(T x 1)$ factor variables in the first-stage. The results of this regression are $(N x 1)$ OLS coefficient vector estimates. These are in turn used as explanatory variables in the second stage cross-sectional regression of $(N x 1)$ returns $\mathbf{r}_t$ for each time period t. The Fama/MacBeth (1973) coefficient estimator is then just the time series average of OLS coefficient estimates of the return for each time period.

There are variants of this estimator, which differ in the use of the estimation technique in the second stage of the two-pass procedure. Instead of using OLS, in some variants Generalized Least Squares (GLS) or Weighted Least Squares (WLS) are applied in the second stage with weighting matrices based on the residuals of the first stage OLS regressions.[7]

The version of the Fama/MacBeth (1973) procedure that is frequently used in the corporate finance or capital structure context is just to conduct the second stage of the procedure above, using OLS. For panel data with small T and large N, the cross-sectional coefficient vector is estimated using OLS for each time period. The Fama/MacBeth (1973) estimator is then again just the time-series average of cross-sectional OLS estimates over the time periods. The Fama/MacBeth (1973) procedure in general is visualized in Fig. 3.

Fig. 3: Fama/MacBeth (1973) procedure

The Fama/MacBeth (1973) procedure used in the capital structure context yields the estimator $\hat{\boldsymbol{\beta}}_{FM}$ by taking the time series average (t = 1,...,T) of cross-sectional (i = 1,...,N) OLS coefficient estimates $\hat{\boldsymbol{\beta}}_t$.



It is a common misunderstanding that this procedure corrects for the major correlation problem in typical panel data. Basically, there are two possibilities of error term correlation in regressions with financial panel data. First, the error terms of a time period may be correlated over the cross-section. This shall be called cross-sectional correlation and results for example when the same macroeconomic factors are relevant for all firms in the sample, or time-series of returns are examined. Petersen (2007) simulates a linear model with a time-variant unobserved variable that is constant over the cross section, which produces such correlation struc-

ture in the error terms. The Fama/MacBeth (1973) procedure, which is designed for this type of problem, yields unbiased standard error estimates in his simulations.

Second, the error term for a given cross-sectional unit (an individual like a firm) will probably be correlated over time, since repeated observations from one company will be more similar to each other than observations across companies. This shall be called serial correlation. Moreover, it is likely that some capital structure relevant variables cannot be observed, resulting in endogeneity problems due to omitted variables. If the unobserved variable is time-invariant, this will cause serial correlation in the error terms as well. Using Monte-Carlo-simulations, Petersen (2007) shows that both OLS and the Fama/MacBeth (1973) standard errors are systematically biased downward in this case. As a result, the Fama/MacBeth (1973) procedure should not be used with regression specifications in a capital structure context, when it is likely that some relevant variables are unobservable, or in the likely case that firm heterogeneity is prevalent. Otherwise, inference based upon Fama/MacBeth (1973) standard errors will produce too large test statistics and reject test hypotheses too often.

In the capital structure context, where the major econometric problem is firm heterogeneity, instead of the Fama/MacBeth (1973) procedure one should use panel estimators. The standard fixed effects estimator controls for firm heterogeneity by allowing for firm specific intercept terms in the regression (Greene 2003, chap. 13), which corresponds to the inclusion of dummy variables for each individual (firm) in the sample.[8] This estimator is consistent in the classic panel context, because it takes out the common, time invariant and firm-specific component in the regression's error term.

Tab. 4 summarizes the results of a Fama/MacBeth (1973) regression for the sample of German firms. Compared to the fixed effects regression results, the signs and magnitudes of the estimated coefficients remain stable.[9] Also, inference on the six core variables of Frank/Goyal (2007) is basically not affected, since standard errors are very small, such that the downward bias of the Fama/MacBeth (1973) regression does not affect the results, as compared to the fixed effects baseline model. There is no reason to expect this to be a general result, however.

Tab. 4: Fama/MacBeth (1973) regression for German firms, 1987-2006

The dependent variable is market leverage. All regressor variables are lagged one year. Year dummies have been included. Sign FG is the sign of the coefficient estimate found in Frank/Goyal (2007). p-values are in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Regressors	Sign FG	Fama/MacBeth (1973) Regression	Baseline Model (FE)
Constant		-0.150 (0.000)***	-0.493 (0.000)***
Profitability	[-]	-0.362 (0.000)***	-0.237 (0.000)***
Size	[+]	0.029 (0.000)***	0.050 (0.000)***
Market-to-Book	[-]	-0.037 (0.000)***	-0.007 (0.000)***
Tangibility	[+]	0.124 (0.000)***	0.112 (0.000)***
Industry Median Debt	[+]	0.350 (0.000)***	0.111 (0.000)***
Expected Inflation	[+]	-	-0.007 (0.005)***
N		8802	8802
R-squared		0.363	0.259
F-test		366.26 (0.000)***	94.02 (0.000) ***
F-test fixed effects		-	16.41 (0.000)***
F-test year dummies		-	43.68 (0.000)***

II. Endogeneity

In the econometric context, a regressor is said to be endogenous if it is correlated with the error term of the data generating process in the population. Endogeneity problems mainly arise due to omitted variables, measurement error of explanatory variables, or if there is (also) a reverse causality between the dependent and the explanatory variables, i.e. the dependent variable causing some explanatory variable as well.[10] The consequence of endogeneity is that OLS will be biased and inconsistent, which renders all point estimates of coefficient and inferences invalid.

The problem of omitted variables is presumably the most common reason for endogeneity. For instance, endogeneity may occur if either some variable suggested by the underlying theory in a capital structure analysis is ignored, or the variable cannot be considered due to data unavailability. As a consequence, the variation of the omitted variable is captured in the error term. If omitted variables are correlated with some regressors in the specification, the error term and these regressors will be correlated and thus be endogenous.

This problem can be alleviated, if the omitted variables are time invariant. A simple fixed effects panel estimator would be robust, because the dummy variables included to control for the individual effect automatically control for any time-invariant variable. This constitutes a compelling reason to employ panel estimators wherever possible. It also makes a strong argument to use fixed effects (or estimators based on first-differencing) rather than random effects estimators, because random effects require that the regression's other explanatory variables are uncorrelated with the individual effects (Greene 2003, chap. 13).

A further possible source of endogeneity can arise if some relevant variables are measured with error. Very often, there is only the availability of some proxy variable that naturally measures the true variable with some error. For instance, in capital structure research it is common to include a regressor controlling for growth opportunities of a firm. A standard proxy for this variable is Tobin's Q, typically measured by the market value of assets divided by the book value of assets. This proxy can only be a noisy signal for true growth opportunities, because it is just one of the set of possible measures for growth opportunities (only broadly reflecting the idea to measure the marginal benefit of investment relative to its marginal costs), and it is based upon book values that are often proxies and imperfect measures of some variable of interest themselves. The resulting measurement error is captured by the error term and can lead to correlation of the error term and regressors.

Given endogenous regressors, standard OLS coefficient estimates are biased and inconsistent, that is, their probability limits are not the true values of the data generating process in the population. One possibility to cope with these types of endogeneity is to apply instrumental variable estimation. A feasible instrument is one which is sufficiently correlated with one of the endogenous variables, but not with the others. However, it is often difficult to find appropriate instruments, though panel data often offers a solution by relying on lagged values of variables, which then are predetermined. The caveat is, as demonstrated by the classic study by Nelson/Startz (1990) that instrumental variable techniques can lead to very poor finite-sample results, if the instruments are weak.

In capital structure studies, usually a multitude of explanatory variables, which are potentially endogenous with the debt ratio is used. For instance, endogeneity arises in this context, if adjustments of the capital structure take time (see the next section for a discussion of dynamic adjustments), if capital structures are chosen to maximize firm value as approximated by Tobin's Q, if some explanatory variables are measured with error, and so on. Hence, as a general

recommendation, researchers on capital structure issues should systematically at least document, whether their main findings are unaffected, if they try to take potential endogeneity into account.

To illustrate the sensitivity of results, when considering potential endogeneity , Tab. 5 summarizes the results of an instrumental variable regression with fixed effects applied to our sample of German firms. In this illustration, the endogenous lagged dependent variable, the (market) debt ratio, is instrumented with lagged book leverage. This is the situation addressed in detail by Flannery/Rangan (2006), discussed in Sections D.I.2 of this paper.

Compared to the baseline results repeated in column 4 of Table 5, the industry median debt ratio and expected inflation lose their significance. Also, the magnitudes of some effects decrease significantly, for instance for profitability and tangibility, compared to the fixed effects regression.

It is important to emphasize, that applying an instrumental variable regression for some potentially endogenous variables is no sufficient condition for having “better” results, in particular, because of the weak instrument problem, and the multitude of possibly endogenous variables. The best a researcher can hope to find is that estimation results are qualitatively not affected, when taking endogeneity into account. In our German illustration, this is not the case, since the significance of some variables vanishes and coefficient magnitudes change. Without further analysis, it remains unclear, whether the baseline model or the instrumental variables estimation is preferable. The results in Tab. 5 illustrate, however, that applying an instrumental variables estimator can have a strong impact on estimation results.

Tab. 5: Fama/MacBeth (1973) regression for the Frank/Goyal (2007) variables for German firms, 1987-2006

The dependent variable is market leverage. All regressor variables are lagged one year. Year dummies have been included. Sign FG is the sign of the coefficient estimate found in Frank/Goyal (2007). Lagged market leverage has been instrumented with lagged book leverage. p-values are in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Regressors	Sign FG	Instrumental Variable with Fixed Effects Regression	Baseline Model (FE)
Constant		-0.222 (0.000)***	-0.493 (0.000)***
Lagged Market Leverage		0.492 (0.000)***	-
Profitability	[-]	-0.066 (0.000)***	-0.237 (0.000)***
Size	[+]	0.025 (0.000)***	0.050 (0.000)***
Market-to-Book	[-]	-0.003 (0.000)***	-0.007 (0.000)***
Tangibility	[+]	0.049 (0.000)***	0.112 (0.000)***
Industry Median Debt	[+]	-0.023 (0.154)	0.111 (0.000)***
Expected Inflation	[+]	0.000 (0.945)	-0.005 (0.073)*
N		8802	8802
R-squared		0.722	0.259
F-test		-	94.02 (0.000)***
F-test fixed effects		2.22 (0.000)***	16.41 (0.000)***
F-test year dummies		-	43.68 (0.000)***

III. Dynamic Adjustment

Dynamic adjustments of actual capital structures should be incorporated into an empirical model, when adjustment costs keep firms away from their desired debt ratio, at least in the short run (Leary/Roberts 2005). To this end, the model needs to include a lagged dependent variable. Accordingly, dynamic adjustment cannot be captured econometrically, when relying on a cross-section of firms. Panel data, however, inherently allows incorporating these partial adjustment issues. Unfortunately, standard panel estimators like the fixed effects regression are biased, when a lagged dependent variable is included in the true data generating process (Arellano/Bond 1991). In this case, the lagged dependent variable is correlated with the error term, and thus necessarily endogenous. This effect is not resolved, when taking first differences, as e.g. the fixed effects estimator implicitly does (Greene 2003, chap. 13).

As an econometric solution to this problem, one can use so-called dynamic panel estimators, which rely on instrumental variables estimation in the Generalized Method of Moments-

framework (GMM). For example, the Arellano/Bond (1991) estimator takes first differences of the panel data (thereby wiping out the individual effects) and resolves the endogeneity problem by using lagged levels and differences of the dependent variable as instruments in a GMM framework. This estimator is for a large number of individuals with few time observations (i.e. panel data) asymptotically unbiased.

Huang/Ritter (2007) analyze several econometric methods that can be applied to estimate partial adjustment models in the capital structure context. Mainly, researchers are in this context interested in the speed of adjustment, that is, one minus the estimated coefficient on the lagged dependent variable in the partial adjustment models. In the capital structure context, debt ratios as dependent variables tend to exhibit large persistence. A large part of variation of future debt ratios can be explained by past debt ratios, which may result in coefficient estimates of the lagged dependent variable near to one. A simple measure of persistence is the correlation of market leverage and its first lag, which for example is 0.87 for our sample of German firms.

Given this magnitude of persistence, Huang/Ritter (2007) show that standard econometric methods are unable to obtain unbiased estimates of the speed of adjustment in partial adjustment models for finite sample. The authors conduct several Monte Carlo simulations in order to calculate the biases associated with common methods in the analysis of debt ratio changes, given the typical financial panel data structure. Huang/Ritter (2007) find that applying pooled OLS leads to upward biased coefficient estimates and applying fixed effects estimation leads to a downward bias of the estimate of the speed of adjustment. Moreover, the bias with fixed effects estimation increases the smaller the time dimension of the data.

In their simulations, Huang/Ritter (2007) also find that first differencing GMM estimators such as Arellano/Bond (1991) and system GMM estimators such as Arellano/Bover (1995) or Blundell/Bond (1998) may all be substantially biased for the considered type of data, conditional on the true speed of adjustment. The bias mainly occurs, because first differences of highly persistent dependent variables are close to zero, rendering first differences of the dependent variable weak instruments. In their setup, the estimator with the smallest finite-sample bias is the Hahn et al. (2007) long differencing estimator, because this estimator is based upon less moment conditions and remedies the problem of weak instruments.

To illustrate the impact of taking dynamic adjustments into account and relying on different estimators, Tab. 6 summarizes the results of an Arellano/Bond (1991) regression, instrumental variables with fixed effects, and fixed effects regressions for our sample of German firms. We do not report estimation results for the Hahn et al. (2007) long-difference estimator, because this estimator is not yet implemented in standard econometric software.

Tab. 6 shows that the Arellano/Bond (1991) coefficient on lagged market leverage is about one third larger than the instrumental variable estimate for German companies. Thus, different econometric methods can yield substantial differences in the estimation of speeds of adjustment with highly persistent data. Note that the adjustment speed for deviations from the target is equal to one minus the coefficient on the lagged dependent variable. Hence, for German firms, Tab. 6 shows a much faster speed of adjustment estimate using the instrumental variable estimation than with the mean differencing Arellano/Bond (1991) estimation. This finding is consistent with Huang/Ritter (2007), who find downward-biased speeds of adjustment for mean differencing methods.

Finally, it is remarkable that incorporating dynamic adjustment (and the choice of the estimator) has a severe impact on the other model implications. In the Arellano/Bond (1991) regression, coefficients on profitability, market to book and industry median debt have the opposite sign than in the baseline model, still being highly significant. Coefficient signs remain unaltered using the fixed effects model with an instrumented lagged dependent variable, though as with the Arellano/Bond estimator, tangibility and size lose their significance. Below, the section on dynamic trade-off models will provide further empirical evidence on different speeds of adjustment.

It is worth emphasizing that due to the high persistence of debt ratios, probably none of the estimation results shown in Tab. 6 will reflect true adjustment speeds, but the methodological papers discussed seem to suggest, that the Arellano/Bond results in the third column of Tab. 6 are likely to be least reliable (also see Flannery/Rangan 2006). It remains an open issue, which dynamic panel estimator has in the context of capital structure data adequate finite-sample properties. The work by Hahn et al. (2007) and Huang/Ritter (2007) provide some initial insights in this regard, but further research needs to be done.

Tab. 6: Arellano/Bond (1991) regression, instrumental variables with fixed effects, and fixed effects regressions for German firms, 1987-2006

The dependent variable is market leverage. All regressor variables are lagged one year. Year dummies have been included. Sign FG is the sign of the coefficient estimate found in Frank/Goyal (2007). Lagged market leverage has been instrumented with lagged book leverage. p-values are in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Regressors	Sign FG	Arellano/Bond (1991) Regression	Instrumental Variable with Fixed Effects Regression	Baseline Model (FE)
Constant		0.085 (0.408)	-0.222 (0.000)***	-0.493(0.000)***
Lagged Market Leverage		0.726 (0.000)***	0.492 (0.000)***	-
Profitability	[-]	0.146 (0.000)***	-0.066 (0.000)***	-0.237 (0.000)***
Size	[+]	0.003 (0.651)	0.025 (0.000)***	0.050 (0.000)***
Market-to-Book	[-]	0.001 (0.025)**	-0.003 (0.000)***	-0.007 (0.000)***
Tangibility	[+]	0.018 (0.461)	0.049 (0.000)***	0.112 (0.000)***
Industry Median Debt	[+]	-0.127 (0.000)***	-0.023 (0.154)	0.111 (0.000)***
Expected Inflation	[+]	0.004 (0.006)***	0.000 (0.945)	-0.005 (0.073)*
N		7704	8802	8802
F-test fixed effects		-	2.22 (0.000)***	16.41 (0.000)***
F-test year dummies		597.09 (0.000)***	-	43.68 (0.000)***

D. Promising Directions of Empirical Capital Structure Research

I. Shocks to the Capital Structure and Adjustment Behavior

1. Equity Value Shocks

Since the existence of firm adjustment behavior to capital structure shocks appears as the main feature that allows for testing the trade-off versus other theories (Myers 1984), one important way to learn about capital structure issues is to examine firm behavior after exogenous shocks. The inherent difficulty is to decide (or reach agreement) on the exogeneity of economic events. One particularly interesting attempt in the literature to test for adjustment behavior by Welch (2004) relies on market-value-based leverage shocks due to stock price changes.

The market-value based capital structure changes with the market price of equity, and therefore at almost any given point in time, given the volatility of today's equity markets. How do

firms behave after (exogenous) stock return shocks to their market based capital structures? Welch (2004) examines, whether firms adjust their capital structures after these shocks to maintain some target debt ratio by issuing and repurchasing debt and equity. The analysis is based on data of publicly traded U.S. corporations from the period 1962 to 2000 available in COMPUSTAT and CRSP, where some size restrictions are applied, but financially restricted firms are included.

Welch (2004) introduces the following variables into his econometric specification: The actual debt ratio (ADR) and the implied debt ratio (IDR) for all i are given by

$$ADR_{t+1} = \frac{D_{t+1}}{E_{t+1} + D_{t+1}}, \quad IDR_{t,t+1} = \frac{D_t}{E_t\left(1 + x_{t,t+1}\right) + D_t} \tag{1}$$

The variable ADR_{t+1} is the market-value debt ratio at time $t+1$, where D_{t+1} is debt and E_{t+1} is equity at the corresponding time. The variable $IDR_{t,t+1}$ denotes the debt ratio that is implied if the firm issued neither debt nor equity from t to $t+1$, where $x_{t,t+1}$ is the stock return without dividends in this period. The Welch (2004) basic regression equation for all i is then

$$ADR_{t+1} = \alpha_0 + \alpha_1 ADR_t + \alpha_2 IDR_{t,t+1} + \varepsilon_{t+1}, \tag{2}$$

where ε_{t+1} is an error term.

Using this framework, Welch (2004) tests two hypotheses. First, if firms perfectly readjust after equity shocks, the current actual debt ratio should correspond to the future actual debt ratio, suggesting $\alpha_1 = 1, \alpha_2 = 0$. Second, if firms do not readjust at all after stock return shocks, but let their capital structure fluctuate freely, this suggests $\alpha_1 = 0, \alpha_2 = 1$.

Using the Fama/MacBeth (1973) procedure, Welch (2004) obtains the following coefficient estimates

$$\hat{ADR}_{t+1} = \underset{(-35.71)}{-0.05} ADR_t + \underset{(728.57)}{1.02} IDR_{t,t+1}, \quad R^2 = 96.3\%, \tag{3}$$

where t-statistics are reported in parentheses. The estimated *ADR* coefficient for the yearly data is economically very close to zero and the estimated *IDR* coefficient is almost equal to one.

Hence, firms do not readjust their capital structure to a target value after equity value changes within a year. The future actual debt ratio is basically one-to-one determined by *IDR* in this specification. Welch (2004) conducts further regressions that consider different time horizons of more than a year, finding only weak adjustment behavior even in the long-run. Equity shocks remain the main determinant of capital structure in his analysis also after controlling for standard proxies used in capital structure research.

The Welch (2004) study exemplifies the basic idea of using exogenous shocks to capital structures to test for firm adjustment behavior. However, it also illustrates the typical problem – if investors in equity markets are fully rational, and stock prices reflect available information, then the equity value will reflect future expected changes in the determinants of firm capital structure. In turn, if the capital structure affected firm value, the capital structure and the change in equity value would be endogenous. This causes some concerns, whether the analysis by Welch (2004) indeed represents a valid test for firm adjustment behavior.

The study also raises several other issues:

Sample Selection: Welch's (2004) sample includes firms with regulated capital structure, like banks.

Estimation: Inference is based on standard panel estimators, which are biased in the context of dynamic adjustments. This is potentially relevant under the hypothesis of any adjustment behavior, since the right-hand side of equation (2) includes a lagged dependent variable.

Implicit Restrictions: There might be a difference in firm reaction with regard to expected versus unexpected stock price changes. The Welch specification assumes that firms react similar to either of the two, since the implied debt ratio reflects both effects and allows for just one coefficient of adjustment.

However, it seems that most of these issues do not affect the qualitative result of Welch (2004). Elsas/Florysiak (2008) use Monte Carlo simulations to analyze the empirical properties of several estimators in the Welch setting of capital structure analysis. As it turns out,

simple OLS and the Fama/MacBeth (1973) approach are the most robust estimators in this context and show only a minor bias of coefficients (as opposed to the Arellano/Bond (1991) dynamic panel estimator, which is heavily biased in this setting).

Moreover, when replicating the Welch (2004) analysis relying on the same merged COMPUSTAT/CRSP database, regression results are unaffected by the sample characteristics. For example, if Welch's (2004) firm size-selections are ignored and firms with a regulated capital structure are excluded from the sample (i.e. financials and utilities), OLS results read as follows

$$\hat{ADR}_{t+1} = \underset{(-15.05)}{-0.072}\, ADR_t + \underset{(209.96)}{0.990}\, IDR_{t,t+1}, \quad T = 37, \quad NT = 117087. \tag{4}$$

It matters, however, if one differentiates between expected and unexpected shocks to equity prices (and therefore capital structure). Using estimated betas and implied expected returns from a 5-year rolling-window estimation, an OLS estimate of ADR_{t+1} on lagged ADR_t, the expected debt ratio $EDR_{t,t+1}$ (i.e. the expected capital structure taking expected stock returns into account) and the unexpected change in capital structure ('$Surprise_{t+1}$') is

$$\hat{ADR}_{t+1} = \underset{(1.8)}{0.341}\, ADR_t + \underset{(2.7)}{0.553}\, EDR_{t,t+1} + \underset{(76.0)}{0.952}\, Surprise_{t+1}, \quad T = 22. \tag{5}$$

Note that adding $EDR_{t,t+1}$ and $Surprise_{t+1}$ yields $IDR_{t,t+1}$. Equation (5) implies that firms do adjust to expected changes in the capital structure, since the coefficient on $EDR_{t,t+1}$ is much smaller than one. The coefficient of 0.952 on *Surprise* shows that there is little adjustment to unexpected shocks, however. This result implies to examine a more elaborated model of dynamic capital structure adjustments, which is the basic idea of Flannery/Rangan (2006).

2. Dynamic Adjustment to Target Leverage and Adjustment Speed

In the dynamic version of the classic trade-off theory, target leverage can be time-varying. If there are (for any reason) deviations from the optimal capital structure, the theory states that there will be adjustment toward the "optimal" target. Depending on the costs of adjustment, target leverage will be adjusted at a different pace.[11] The major objective of capital structure research using dynamic partial adjustment models is then to estimate the speed of adjustment. In this regard, this strand of the literature is similar to Welch (2004), but the designs differ

fundamentally in terms of the empirical model. And contrary to Welch (2004), these studies systematically find adjustment behavior, though speed of adjustment estimates are within a rather large range.

Flannery/Rangan (2006) analyze whether U.S. firms indeed have long-run target capital structures and if so, how fast they adjust to this target. In comparison to prior studies, they put special emphasis on the econometric methods and the model specification, emphasizing the need to take the panel nature of the data into account.[12]

Target leverage of firm i at time $t+1$ is determined by a vector of firm characteristics $\mathbf{X}_{it}$ that are related to the trade-off between the costs and benefits of debt in different capital structures.[13] Target leverage is given by

$$MDR^{*}_{i,t+1} = \boldsymbol{\beta}\mathbf{X}_{it}\,, \tag{6}$$

where $\boldsymbol{\beta}$ is a coefficient vector, and MDR denotes market debt ratio.[14] For firms to have a target capital structure, there must be at least some elements of $\boldsymbol{\beta}$ different from zero.

The partial adjustment model of Flannery/Rangan (2006) is given by

$$MDR_{i,t+1} = (\lambda\boldsymbol{\beta})\mathbf{X}_{it} + (1-\lambda)MDR_{i,t} + \mu_i + \tilde{\delta}_{i,t+1}\,, \tag{7}$$

where λ is the adjustment speed coefficient, μ_i a time-invariant unobserved variable (firm fixed effect), and $\tilde{\delta}_{i,t+1}$ an error term. The speed of adjustment is assumed to be the same for all firms and captures the extent to which deviations from optimal leverage are eliminated in each period: if the current deviation from the target debt ratio marginally increases, the difference between the future and the current debt ratio increases by λ. If $\lambda = 0$, the speed of adjustment is zero, that is, there is no adjustment at all. If $\lambda = 1$, the speed of adjustment is infinitely high, that is, the debt ratio is always at its target value.

Tab. 7 shows results of instrumental variable estimations controlling for time-invariant and firm-invariant unobserved variables (time and firm fixed effects) of the partial adjustment model in (7). It summarizes the core regression results of Flannery/Rangan (2006) shown in their Table 2, model 7, and compares them to a similar regression for our German firm sample. Slight differences in the empirical model for Germany occur, because data for construct-

ing a rating dummy is not available for the German sample. However, few non-financial firms in Germany are rated, such that we do not expect this to affect the empirical results. Similar to Flannery/Rangan (2006), we include a dummy indicating if German firms did not report research & development expenditures (R&D), and set in this case the variable to zero. This serves to avoid biases from the fact that reporting R&D expenditures is voluntary under both the U.S. and German accounting standards.

In terms of the Flannery/Rangan (2006) results in column 3, most of the firm characteristics $\mathbf{X}_{it}$ that determine the target capital structure are highly significant after controlling for the lagged market debt ratio, which supports the existence of a target leverage. According to the estimated coefficient on $MDR_{i,t}$, the speed of adjustment is $\lambda = 1 - 0.656 = 0.344$, thus significantly different from zero in a statistical and economic sense. Hence, about 34 % of the deviation from optimal leverage is eliminated in each period, taking about three years for the average firm to adjust to its target capital structure following shocks. The corresponding estimation results for German firms (column 2) show that the adjustment speed is at 49% much faster. In terms of the other explanatory variables, estimated coefficients for market-to-book, industry median leverage and R&D expenditure exhibit the largest differences between the German and the U.S. sample. For example, market-to-book is significant in the German sample and insignificant with Flannery and Rangan (2006), where the opposite holds for industry median leverage. Moreover, the effect of R&D expenditures is much larger in the German sample. Similar to Flannery/Rangan (2006), however, firm fixed effects explain a large proportion of the cross-sectional variation of the market debt ratio of German firms.[15] Ignoring firm-individual effects would lead to much lower adjustment speed estimates and a misspecified model, emphasizing the need to take the panel nature of the data into account.

Tab. 7: Flannery/Rangan (2006) regression results and instrumental variables with fixed effects regression for German firms, 1987-2006

The dependent variable is market leverage. All regressor variables are lagged one year. Year dummies have been included. Lagged market leverage has been instrumented with lagged book leverage. Depreciation and R&D expenditure are divided by total assets. p-values are in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Regressors	Instrumental Variable Regression, Fixed Effects (German sample)	Flannery and Rangan (2006), Instrumental Variable Regression, Fixed Effects (U.S. firms)
Constant	-0.216 (0.000)***	-
Lagged Market Leverage	0.506 (0.000)***	0.656 (0.000)***
Profitability	-0.075(0.000) ***	-0.030 (0.000) ***
Size	0.025 (0.000) ***	0.025 (0.000) ***
Market-to-Book	-0.003 (0.000)***	0.000 (0.418)
Tangibility	0.057 (0.000) ***	0.053 (0.000) ***
Industry Median Debt	-0.025 (0.124)	0.034 (0.000) ***
Depreciation	-0.104 (0.000) ***	-0.226 (0.000) ***
Expected Inflation	-0.000 (0.960)	-
R&D Expenditure	-0.166 (0.005) ***	-0.025 (0.000) ***
No R&D Expenditure Reported [Dummy]	-0.011 (0.014)**	0.000 (0.010) ***
Firm is Rated [Dummy]	-	0.003 (0.087)*
N	8,802	111,106
R-squared	0.465	0.466
F-test fixed effects	2.16 (0.000)***	-
Wald-test year dummies	1068.2 (0.000)***	-

Complementing the type of analysis of dynamic adjustment behavior as exemplified by the Flannery/Rangan (2006) study, some studies combine a theoretical and empirical analysis. The underlying theoretical models are constructed such that they account for as many stylized facts as possible, but also generate new hypotheses. The theoretically derived firm behavior is then simulated, generating data with known properties of the firms' capital structure determinants. The data is then used to test the characteristics of standard econometric estimators in this context.

As a recent example for this type of analysis, Titman/Tsyplakov (2007) present a model of the dynamic trade-off class, incorporating firm investments triggered by product market changes, deadweight costs of financial distress, and debtholder/equityholder agency problems. They

simulate model-generated panel data for debt ratios, cash flows and investment choices and conduct partial adjustment regressions as in Flannery/Rangan (2006) and others. In this simulated universe, the speed of adjustment is about 7.1% under realistic parameter settings. This magnitude is similar to the real-world estimates by Kayhan/Titman (2007) and Fama/French (2002), but slower than the estimate by Flannery/Rangan (2006). Furthermore, Titman/Tsyplakov (2007) show that there is a strong association between the equity returns of companies and their debt ratios, supporting the similar results by Welch (2004).

3. Major Real Investments

Another strand of the literature analyzes a fundamentally different shock to capital structures of firms, but in a dynamic context as well. The studies by Mayer/Sussman (2005) and Elsas et al. (2007) examine dynamic financing patterns of U.S. firms, when these undertake major real investments from their perspective. Mayer/Sussman (2005) consider equity and debt issues following spikes in firms' investment expenditures, while Elsas et al. (2007) examine jumps (rather than spikes) in capital expenditures. Here, a major investment occurs if

> (i) investment expenditures exceed 200% of the firm's past three years' average investment level (its "benchmark" investment), and
> (ii) the investment is at least 30% of the firm's prior year-end total assets.

Note that examining spikes in investment expenditures mainly leads to the identification of major acquisitions, because the investment pattern is defined to be a major increase followed by a subsequent corresponding decrease. In contrast, the definition of Elsas et al. (2007) identifies major acquisitions and internal investment, because no decrease in investment expenditures is mandated.

Both studies pursue the idea that the exercise of very large real investment options allows to observe major financing decisions by firms. Moreover, if the major real investment is more driven by the availability of the investment opportunities rather than the availability of investment funding, it will constitute an exogenous shock to the sample firms' capital structure.

Another novelty of both studies is that they rely on an event driven framework that is particularly suited to analyze adjustment behavior. Focusing on investment events helps separating new and extraordinary investments from "normal" investments, which often reflect the maintenance of assets already in place. The event perspective allows in addition to trace financing

patterns by separating newly issued funds induced by the investment from repayments and refinancing transactions. Also, as pointed out by Leary/Roberts (2005) and Hovakimian et al. (2004), if adjusting capital structures entails some fixed cost, firms should be closest to their desired capital structure after major recapitalizations.

Both studies use the COMPUSTAT universe of North-American firms and identify firm financing patterns driven by the major investments out of the cash flow statements of these firms. This allows for disentangling external from internal investment financing. Surprisingly, major investments are primarily financed using external funds, in particular debt financing. In addition, Mayer/Sussman (2005) show that external funds are used before internal funds are exhausted, contradicting a strict pecking order of financing, though the observed debt preference is consistent.

Both studies also show that there is adjustment behavior. Mayer/Sussman (2005) find that about 70 % of capital structure disturbances due to the investment event are offset after five years for large firms. Elsas et al. (2007) show in addition, that even in the event year, the financing of the major investment moves the firm strongly towards its target capital structure, in the frequent case, where financing is predominantly based on debt financing.[16] However, equity issuances in both studies contradict patterns consistent with trade-off and pecking order theory. Mayer/Sussman (2005) report that up to 35 % of event firms issue equity several times around investment spikes, while Elsas et al. (2007) document that in particular small firms rely more on equity financing. Elsas et al. (2007) also show that stock-price run-ups preceding the major investment strongly increase the likelihood of equity issues, consistent with market-timing behavior.

4. Macroeconomic Shocks

One stream of literature is concerned with the impact of macroeconomic conditions on corporate leverage. Macroeconomic shocks are highly exogenous to the single firm in the economy. Within their analysis, Hackbarth et al. (2006) provide an overview of recent theoretical works in this area. In an empirical study, Campello (2003) analyzes the influence of exogenous shocks in the product market environment on capital structure, using aggregate demand shocks as a proxy. He finds that debt financing and relative-to-industry sales growth have a negative relationship in industries with low industry leverage during recessions, but not during booms. This effect cannot be observed in industries with high industry leverage. In a fur-

ther empirical analysis, Korajczyk/Levy (2003) also examine the impact of macroeconomic conditions on leverage, controlling for firm-specific variables. They find financially unconstrained firms issue equity pro-cyclically and debt counter-cyclically, although the underlying economic rationale remains somewhat unclear.

II. Further Potential Determinants of Capital Structure

1. Ratings

The study by Kisgen (2006) emphasizes a determinant of capital structure decisions that has received only little attention before – the rating of companies by external rating agencies like Moody's or S&P. Kisgen (2006) tries to analyze how the financing behavior of firms is affected if firms are near credit rating upgrades or downgrades.[17] The basic idea is that under both the trade-off and the pecking order theory the capital structure depends on the (marginal) costs of debt and equity. Since rating changes might affect the costs of capital, potential rating changes through financing decisions can alter the target debt level or the marginal benefit of debt over equity, rendering the corporate rating a potentially important determinant. Arguably, this effect will be strongest the closer a firm is to a rating change.

Correspondingly, Kisgen (2006) analyzes firm financing decisions, when firms are close to rating changes and finds that these firms issue significantly less debt than other comparable firms. This finding is robust even if one controls for several differing approaches to take "standard" capital structure determinants into account.

However, there is one potential issue with the empirical design of Kisgen (2006). The proxies he uses to identify firms close to a rating change seem uninformative regarding the probability of a rating change. His results are primarily based on firms being in a + or – notch on the S&P corporate rating scale. These are, however, only ordinal categories for some probabilities of default and not necessarily related to an intended change of the ratings. Indeed, Kisgen (2006) reports that the likelihood of rating changes is barely different for firms in these notches from firms in the main categories (although this might be endogenous). As a solution, testing the validity of the results by Kisgen (2006) could be done by relying on the rating agencies watch list announcements, where an agency publicly announces that a firm will be examined for a change in its rating.[18]

2. Competition and Regulatory Changes

Another potential set of determinants of capital structure decisions is the competitive and regulatory environment of firms. These constitute determinants in the first place, but offer at the same time the possibility to observe shocks to the firm that are exogenous. The classic study by Zingales (1998) illustrates this idea.

Zingales (1998) analyzes the impact of financing decisions on the survival of firms in the U.S. trucking industry. The basic idea of the study is that firm financing decisions and the competitive environment (the industry structure) are endogenous. The trucking industry in the U.S. had been subject to severe restrictions on price competition. When this was unexpectedly abandoned, fierce competition started and many market entries occurred. Since this was largely unexpected, pre-deregulation capital structures could not reflect the new environment optimally. At the same time, the value of the companies consisted to a large extent of the charter value of the limited competition. Hence the deregulation induced a huge increase in leverage once competition set in, inducing potentially a high pressure on firms to lower leverage to get back to some optimum.

Zingales (1998) estimates survival rates of firms, controlling for pre-deregulation leverage ratios, firm efficiency, and the ex ante default risk. Highly levered firms are less likely to survive the exogenous deregulation shock. As an explanation, among others, firms with high (initial) debt might have fewer possibilities to make investments. Hence, the most efficient firms and the firms with large internal financial resources survive the deregulation. This provides evidence showing the relevance of the underinvestment problem due to too high leverage, and therefore evidence on some of the costs typically associated with debt in trade-off theory. Most remarkably, the unanticipated change in the regulatory framework, probably constitutes a truly exogenous event, such that the results regarding capital structure issues are not subject to endogeneity problems.

3. Behavioral Corporate Finance

Fully rational behavior means that all agents in the market have rational expectations and are expected utility maximizers. In behavioral corporate finance, the assumption of fully rational investors and managers is abandoned. Beliefs and preferences may be non-standard and thus

allow for irrational behavior, and theories taking this into account might lead to new determinants that help improving our understanding of capital structure determinants.[19]

In the behavioral corporate finance literature, two salient approaches have emerged (see Neus/Walter (2008) in this issue). In the irrational investors approach, rational managers are facing irrational investors. The associated literature basically deals with inefficient markets and rational managers exploiting mispricing, such as the market timing story of Baker/Wurgler (2002).[20] In the irrational managers approach, it is assumed that not fully rational managers are operating in efficient markets, i.e. facing rational investors.

Most of the literature in the irrational managers approach focuses on deviations from rational expectations. There is some evidence from social psychology that individuals and especially managers have biased beliefs.[21] Some possible distortions in managerial beliefs emphasized in the behavioral corporate finance literature are optimism and overconfidence (see Barberis/Thaler (2003) for detailed definitions). Optimism is basically the overestimation of the expected value of some quantity. For instance, the manager estimates too large a return on a certain project. This relates to the notion of assessing oneself as being better than average. On the other hand, overconfidence is the underestimation of the variance of some quantity (i.e. underestimation of risk). This leads to confidence interval estimates that are too narrow, where e.g. the manager then estimates too small a range of returns on a certain project.

Ben-David et al. (2007) analyze, whether CFOs are overconfident and whether this has an impact on corporate policies, including capital structure issues. The authors measure managerial overconfidence based upon stock market predictions made by CFOs. They use a survey[22] of S&P 500 return forecasts of CFOs between 2001 and 2007, in which they directly ask CFOs to predict the 10^{th} and 90^{th} percentiles of the one and ten year return distribution.[23] Their survey data thus allows for differentiating between overconfidence and optimism (as defined above), because the gathered information on the estimated index level and the expected dispersion allows disentangling these two characteristics. Based on their survey, overconfidence is a measure based upon the implicit standard deviation of estimated confidence interval bounds.

Ben-David et al. (2007) derive several hypotheses on corporate policies from a simple model incorporating overconfident managers. The financing-related hypotheses state that overconfident managers perceive their firms' equity to be undervalued by the market, that leverage in-

creases with managerial overconfidence, and that overconfident managers repurchase shares more often. They find that CFOs are overconfident, i.e. they underestimate the variance of market returns, because realized market returns are within the estimated 80 % confidence intervals only 38 % of the time. Since managerial overconfidence might have an impact on capital structure, it is also important to know, which determinants drive overconfidence. Ben-David et al. (2007) find that the return confidence interval estimates depend on recent past returns and on returns of the CFOs' firms. The lower bound of the confidence interval is more sensitive to past returns than the upper bound, thus managerial overconfidence is fragile and decreases more after low return periods than it increases after high return periods.

Malmendier et al. (2007) test capital structure-related hypotheses using two alternative measures of managerial irrationality. First, they infer from revealed beliefs based upon personal portfolio decisions of CEOs the level of overconfidence.[24] CEOs are compensated with stock options of their firms. Thus, they are under-diversified and should exercise in-the-money options at the earliest possible time to diversify their personal portfolios. Malmendier et al. (2007) suggest that a higher degree of managerial overconfidence induces managers to stick with option rights from after the vesting period. Thus, the excess holding time of employee stock options can serve as proxy for overconfidence. [25] As a robustness check, they use press portrayals of CEOs as an alternative indicator for managerial optimism. Here, higher managerial optimism is assumed to translate into a higher number of corresponding keywords in the portrayals.

The first hypothesis by Malmendier et al. (2007) is that overconfident managers prefer debt to equity conditional upon using external financing, because managers perceive the price of newly issued equity as too low in their model. Their second hypothesis is that managers prefer internal to external financing unconditionally, which might result in using debt too conservatively, thus exploiting the tax benefits not optimally.[26] Testing the first hypothesis, the evidence implies that overconfident CEOs are less likely to issue equity in comparison to their peers, which supports pecking order financing due to overconfidence. Malmendier et al. (2007) also find support for their second hypothesis that overconfident CEOs rely more heavily on internal financing. Furthermore, they find that the longer a firm is managed by overconfident managers, the higher is the firm's leverage in the long term.

E. Conclusions

According to Myers (1984), the key question to differentiate between competing theories on capital structure choices by companies is whether firms adjust to some target following shocks to their capital structure. Our review of recent studies addressing this question shows that some progress has been made, but the evidence is still contradictory. For example, Welch (2004) barely finds any adjustment behavior for U.S. companies following shocks to their market debt ratios from changes in equity values. In contrast, empirical studies estimating partial adjustment models of leverage arrive at estimated adjustment speeds to a target capital structure in the range from 10% up to 50% per year.

Our discussion of corresponding studies indicates that the econometric issue of endogeneity and the panel nature of most datasets appear to be central obstacles, which potentially explain at least partly this contradictory evidence. Overall, however, the evidence, is striking that leverage adjustments do take time (potentially due to fixed costs of issuing new securities), and are a significant characteristic of observed capital structure patterns. Some of the older studies rely on a single cross-section of firm data, which makes it impossible to take dynamic adjustments to the capital structure into account. Studies relying on panel data too often ignore the panel structure at all, potentially leading to flawed inferences. The available evidence uniquely suggests that controlling for firm specific heterogeneity is inalienable. Since standard panel estimators like the fixed effects model are biased under dynamic partial adjustment due to endogeneity, and dynamic panel estimators are plagued by finite-sample biases in the capital structure context, there remain severe methodological issues to be resolved. The papers by Hahn et al. (2007) and Huang/Ritter (2007) provide some initial insights on the choice of dynamic panel estimators in the capital structure context, however.

In the context of testing adjustments following shocks to capital structure, several ideas on what constitutes exogenous shocks have been suggested in the literature, for example including equity value changes and very large investments by firms, as discussed in Section D of this review. Clearly, one promising avenue for future research is to come up with additional events that are indisputably exogenous to the capital structure decision of single firms, and use them to learn about the prevalence of adjustment behavior.

The discussion of empirical studies on additional determinants of corporate leverage, which have gained only recently attention in the literature, illustrates that apart from adjustment be-

havior, there is still room for future theoretical and empirical work. Only recently, the role of rating agencies for capital structure decisions has been analyzed (Kisgen 2006), despite the obvious relevance in modern capital markets. There is probably much future research to do, to really understand the impact of this and other corporate governance mechanisms on capital structure choices. Also, the emerging empirical literature inspired by motives from behavioral finance has revealed that problems other than asymmetric information and agency costs, which are the dominating arguments leading to the classic trade-off or pecking order theories, seem to be of empirical relevance.

With respect to these classical theories, the available evidence is still contradictory, finding empirical results consistent with adjustment behavior and some preference of firms for cash flow financing. But e.g. patterns like the pronounced usage of equity financing for smaller firms (Elsas et al. 2007, Frank/Goyal 2003) remain puzzling in the pecking order context. Quite consistently, however, the evidence suggests that market-timing behavior to some extent explains observed capital structure patterns.

To illustrate the impact of the economic and methodological aspects discussed in our review, we have provided evidence for the sample of exchange listed German firms over the period from 1987 to 2006. On the one hand side, these exercises have shown that taking the panel nature of the data, dynamic adjustment, and endogeneity into account can have a large impact on estimation results. On the other hand, the German evidence also shows that many of the "standard" determinants of capital structures are similarly to the U.S. relevant for corporate finance in Germany. In particular, firm profitability, firm size, and the market-to-book ratio as a proxy for firms' growth options are very robust determinants of capital structure.

In conclusion, it remains an interesting challenge for future (empirical) research, to improve our understanding of circumstances, where certain capital structure determinants are relevant, and to identify (further) reliable empirical patterns and core factors of systematic variation in corporate leverage.

Appendix

This appendix provides details on the data of German exchange listed firms used throughout the study to illustrate the relevance of the methodological and empirical issues discussed.

The base sample consists of all yearly financial statement data available in Hoppenstedt for German exchange listed firms with unregulated capital structures, i.e. excluding financials and utilities. The observation period is from 1987 to 2006. The sample is pooled over accounting standards IAS, US-GAAP, "HGB-Gesamtkostenverfahren", and "HGB-Umsatzkostenverfahren", for consolidated and individual financial statements, in this order of preference. If a firm has both a consolidated and an individual financial statement, the consolidated financial statement has been selected. Market data comes from the Datastream database by Thomson Financial. Financial statement data are deflated using the GDP-deflator with base year 2005. Tab. A.1 describes the construction of variables used in the capital structure regressions throughout the paper.

Tab. A.1: Regression variables and their proxies

Variable	Proxy
Market Leverage	Total Liabilities / (Total Liabilities + Market value Equity)
Book Leverage	Total Liabilities / (Total Liabilities + Equity)
Profitability	EBITDA / (Total Liabilities + Equity)
Size	Natural Logarithm of Sales
Market-to-Book	(Total Liabilities + Market value Equity) / (Total liabilities + Equity)
Tangibility	Fixed Assets / (Total Liabilities + Equity)
Industry Median Debt	Median of Market Leverage by NACE code and by year. Industry is defined as the first digit NACE code level.
Expected Inflation	CPI forecasts by Economist Intelligence Unit

All variables have been winsorized at the 0.5% and 99.5% percentile. The market value of equity has been taken 3 month after the fiscal year end. If a firm year has negative book equity, it has been dropped. After further data cleaning, the sample comprises 1182 firms and 10082 firm years. Tab. A.2 provides descriptive statistics for the regression variables.

Tab. A.2: Descriptive statistics for the regression variables

Variable	Mean	Min	Max	Standard Deviation
Market Leverage	0.452	0.003	0.969	0.254
Book Leverage	0.596	0.015	1.000	0.225
Profitability	0.093	-1.736	0.682	0.159
Size	18.272	10.312	25.695	2.413
Market-to-Book	2.179	0.389	97.260	4.290
Tangibility	0.286	0	1.199	0.234
Industry Median Debt	0.430	0.030	0.835	0.140
Expected Inflation	1.893	0.159	5.091	1.086

Endnotes

[1] A detailed review of theoretical issues can be found in the survey by Neus/Walter (2008) in the same issue of this journal. The classic theory survey is Harris/Raviv (1991), complemented by more recent discussions by Myers (2001), and Frank/Goyal (2008).

[2] See Berk/deMarzo (2007, p. 483) for a similar analysis of U.S. companies.

[3] Frank/Goyal (2007) also assert that it is likely that financing behavior of firms is not constant over time. This points to the dynamic trade-off models that may allow for time-varying target leverage, which will be discussed in Section D in more detail.

[4] See the Appendix for details on the firm sample.

[5] Further problems associated with financial panel data may arise with incomplete data, sample selection and survivorship biases, and outliers in the data. Frank/Goyal (2008) and Welch (2007) provide some starting point for these issues.

[6] Petersen (2007) examines publications in the Journal of Finance, the Journal of Financial Economics, and the Review of Financial Studies over the period 2001-2004.

[7] Shanken/Zhou (2007) provide an overview of the theory and a simulation analysis of the Fama/MacBeth (1973) procedure in the asset pricing context.

[8] Mathematically, this is equivalent to take the first differences of all variables in the regression, run OLS and correct standard errors to the loss in degrees of freedom.

[9] Note that due to the nature of the Fama/MacBeth (1973) procedure, variables that have identical values in a time period for each cross-sectional unit cannot be estimated. In the reported fixed effects regression, which also comprise year dummies and the macroeconomic variable expected inflation, this problem is circumvented by dropping an additional time dummy.

[10] Wooldridge (2002) is an excellent textbook on endogeneity issues.

[11] For more on the theory of dynamic trade-off, see the survey by Frank/Goyal (2008). The review of theoretical literature in Titman/Tsyplakov (2007) is also helpful for an overview on this topic.

[12] Other studies estimating the speed of adjustment are Fama/French (2002), Alti (2006), and Lemmon et al. (2006). Estimates in these studies range from 10% per year up to 34%, always based on samples of U.S. firms.

[13] Flannery/Rangan (2006) use COMPUSTAT data from 1965 to 2001, excluding financials and regulated utilities.

[14] The market debt ratio has been defined as (book value of debt) / (book value of debt + common shares outstanding x price per share).

[15] Flannery/Rangan (2006) also use book debt ratio instead of market debt ratios, but the results do not change significantly.

[16] Elsas et al. (2007) rely on target debt ratios estimated from pre-event observations of the firms using the dynamic partial adjustment approach from Flannery/Rangan (2006).

[17] Kisgen (2006) uses S&P credit ratings and data from COMPUSTAT for North-American firms from 1986 to 2001, excluding financials and utilities.

[18] See Boot et al. (2006) and Hirsch/Krahnen (2007) for an analysis of the disciplining effect of watch list announcements and their informational content.

[19] Barberis/Thaler (2003) on behavioral finance and Baker et al. (2007) on behavioral corporate finance provide nice introductions to these streams of literature.

[20] Baker et al. (2007) discuss the irrational investors approach in depth.

[21] Barberis/Thaler (2003) also provide an excellent review of this evidence.

[22] For more information about this survey, see http://www.cfosurvey.org/.

[23] Excluding utilities and financials, Ben-David et al. (2007) use a sample of 1104 observations with 504 unique firms, for which survey responses and accounting data are available.

[24] The measures of Malmendier et al. (2007) cannot differentiate between overconfidence and optimism.

[25] The CEO data on personal portfolios is taken from Hall/Liebmann (1998) and Yermack (1995) and include data for CEOs of 477 large publicly traded U.S. firms between 1980 and 1994.

[26] Malmendier/Tate (2005) find that CEOs, who are more overconfident than their peers, make more investments if they can use internal cash flows to finance them.

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