Journal of Financial Economics 51 (1999) 219–244

Testing static tradeoff against pecking order models of capital structure[1]

Lakshmi Shyam-Sunder[a], Stewart C. Myers[b,*]

[a] *International Finance Corporation, Washington, DC 20433, USA*
[b] *Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA 02139, USA*

Received 15 April 1994; received in revised form 9 July 1998

Abstract

This paper tests traditional capital structure models against the alternative of a pecking order model of corporate financing. The basic pecking order model, which predicts external debt financing driven by the internal financial deficit, has much greater time-series explanatory power than a static tradeoff model, which predicts that each firm adjusts gradually toward an optimal debt ratio. We show that our tests have the power to reject the pecking order against alternative tradeoff hypotheses. The statistical power of some usual tests of the tradeoff model is virtually nil.

JEL classification: G32

Keywords: Financing; Capital structure; Static tradeoff theory; Pecking order theory

1. Introduction

The theory of capital structure has been dominated by the search for optimal capital structure. Optimums normally require a tradeoff, for example between

* Corresponding author. Tel.: 617 253 6696; fax: 617 258 6855; e-mail: scmyers@mit.edu.

[1] This paper has benefited from comments by seminar participants at Boston College, Boston Unsiversity, Dartmouth College, Massachusetts Institute of Technology, University of Massachusetts, Ohio State University, University of California at Los Angeles and the NBER, especially Eugene Fama and Robert Gertner. The usual disclaimers apply. Funding from MIT and the Tuck School at Dartmouth College is grateful acknowledged. We also thank two reviewers, Richard S. Ruback and Clifford W. Smith, Jr., for helpful comments.

PII: S0304-405X(98)00051-8

the tax advantages of borrowed money and the costs of financial distress when the firm finds it has borrowed too much. A value-maximizing firm would equate benefit and cost at the margin, and operate at the top of the curve in Fig. 1. The curve would top out at relatively high debt ratios for safe, profitable firms with plenty of taxes to shield and assets whose values would escape serious damage in financial distress. This static tradeoff theory quickly translates to empirical hypotheses. For example, it predicts reversion of the actual debt ratio towards a target or optimum, and it predicts a cross-sectional relation between average debt ratios and asset risk, profitability, tax status and asset type.

The empirical literature seems to confirm these two predictions. However, none of these papers has systematically compared the explanatory power of their fitted equations with alternative explanations of financing behavior, and none has checked whether their equations could *seem* to work even when actual financing is driven by other forces. That is, they have not checked the statistical power of their tests against alternative hypotheses.

We propose an alternative time-series hypothesis based on the pecking order theory of optimal capital structure. In the pecking order theory, there is no well-defined optimal debt ratio. The attraction of interest tax shields and the threat of financial distress are assumed second-order. Debt ratios change when

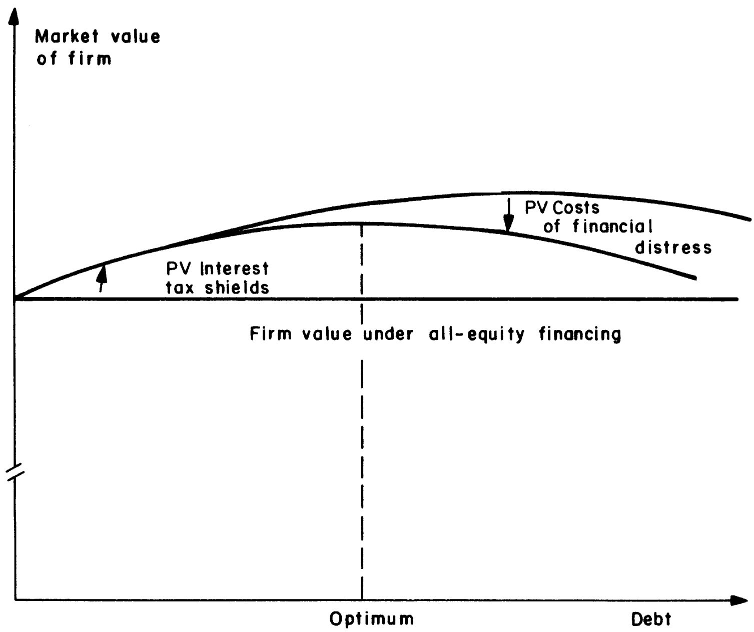

Fig. 1. The static tradeoff theory of optimal capital structure assumes that firms balance the marginal present values of interest tax shields against the costs of financial distress.

there is an imbalance of internal cash flow, net of dividends, and real investment opportunities. Highly profitable firms with limited investment opportunities work down to low debt ratios. Firms whose investment opportunities outrun internally generated funds borrow more and more. Changes in debt ratios are driven by the need for external funds, not by any attempt to reach an optimal capital structure.

We find that a simple pecking order model explains much more of the time-series variance in actual debt ratios than a target adjustment model based on the static tradeoff theory. Moreover, we show that the pecking order hypothesis can be rejected if actual financing follows the target-adjustment specification. On the other hand, this specification of the static tradeoff hypothesis will *appear* to work when financing follows the pecking order. This false positive results from time patterns of capital expenditures and operating income, which create mean-reverting debt ratios even under the pecking order. Thus we have power to reject the pecking order but not the static tradeoff specification. We conclude that the pecking order is a much better first-cut explanation of the debt-equity choice, at least for the mature, public firms in our sample. We question the evidence for a well-defined optimal debt ratio as predicted by the tradeoff theory.

We claim two contributions for this paper. The first is methodological, that is our procedures for testing the statistical power of alternative hypotheses about financing behavior. The second is empirical, based on the excellent performance of a simple, time-series pecking order model, at least for our sample of mature, public companies, and the weak performance of target-adjustment models derived from the static tradeoff theory.

We do not claim that the simple pecking order is the whole story, and we concede that more elaborate tradeoff specifications may work better. Actual financing decisions reflect many motives, forces and constraints. However, elaborate models have their own dangers, because variables may proxy for several different effects. A positive *t*-statistic, against a null hypothesis of a zero coefficient, proves nothing, unless statistical power is demonstrated.

1.1. Prior work

There is evidence in favor of the static tradeoff and optimal capital structure. Several authors, such as Schwartz and Aronson (1967), have documented evidence of strong industry effects in debt ratios, which they interpret as evidence of optimal ratios. Long and Malitz (1985) show that leverage ratios are negatively related to research and development expenditures, which they use as a proxy for intangible assets. Smith and Watts (1992) also document a negative relation between growth opportunities and debt ratios. Mackie-Mason (1990) reports evidence that firms with tax loss carry forwards are less likely to issue debt. This conclusion is consistent with Miller and Modigliani (1966), who detected the positive effects of interest tax shields in the market values of electric utilities.

Bradley et al. (1984) give an excellent review and synthesis of some of the earlier theoretical and empirical literature on optimal capital structure, and conclude that their findings 'support the modern balancing [tradeoff] theory of capital structure'. More recently, however, Titman and Wessels (1988), using a latent variables approach, have found only mixed evidence for the role of the factors predicted by the static tradeoff theory.

Other studies provide more direct evidence that firms adjust toward a target debt ratio. Taggart (1977), Marsh (1982), Auerbach (1985), Jalilvand and Harris (1984) and Opler and Titman (1994) find mean reversion in debt ratios or evidence that firms appear to adjust toward debt targets. Marsh (1982), using a logit model, finds that the probabilities of debt and equity issues vary with the deviation of the current debt ratio from the target, which he estimates as the observed average over his sample period. Opler and Titman (1994), who also use a logit model but estimate the target by a cross-sectional model, come to broadly similar conclusions. Taggart (1977) and Jalilvand and Harris (1984) estimate target-adjustment models and find significant adjustment coefficients, which they interpret as evidence that firms optimize debt ratios. Auerbach (1985) also estimates a target-adjustment model, but allows for firm-specific and time-varying targets. He also interprets the significant adjustment coefficients as support for target-adjustment behavior.

However, other evidence is inconsistent with the optimal debt ratios or can be interpreted differently. First, as pointed out by Myers (1984), the negative valuation effects of equity issues or leverage-reducing exchange offers – see Masulis (1980) – do not support the tradeoff story. If changes in debt ratios are movements towards the top of the curve (as in Fig. 1), both increases and decreases in leverage should be value enhancing.[2] Second, Kester (1986), Titman and Wessels (1988) and Rajan and Zingales (1995) find strong negative relationships between debt ratios and past profitability. Models based on the tradeoff of the tax benefits of debt and the costs of financial distress predict a positive relation.[3]

This empirical literature has been guided almost exclusively, though sometimes implicitly, by the assumption of an optimal debt ratio. In Myers's (1984)

[2] Jensen (1986) suggests an alternative framework to explain this and other evidence on valuation effects of various transactions. However, Jensen's analysis relies on an agency cost theory that is not examined in this paper. The valuation effects of leverage-altering transactions could also be viewed as an information effect of the kind proposed by Ross (1977), in which a decline in profitability would lead to lower debt ratios and send a disappointing signal about future profitability.

[3] This result could be explained in a tradeoff framework if high past profitability is viewed as a proxy for higher future growth opportunities, which are intangible assets that could be severely damaged in financial distress. See Smith and Watts (1992). However, other variables, such as lagged q ratios, that could arguably capture future growth options more directly are not found to be as strongly significant as past profitability. See, for example, Baskin (1985).

and Myers and Majluf's (1984) pecking order model there is no optimal debt ratio. Instead, because of asymmetric information and signaling problems associated with external funding, firms' financing policies follow a hierarchy, with a preference for internal over external finance, and for debt over equity. A strict interpretation of this model suggests that firms do not aim at any target debt ratio; instead, the debt ratio is just the cumulative result of hierarchical financing over time. Firms that face a financial deficit will first resort to debt, and will be observed later at higher debt ratios. This reasoning could readily explain the negative relation between past profitability and debt ratios.

A growing literature considers liquidity constraints on real investment as a result of the asymmetric information problems of external equity financing. See for example, Hoshi et al. (1991), Fazzari et al. (1988) and Whited (1992). In this paper, we take real investment as exogenous, because our sample consists of large, public firms, most with investment-grade debt ratings. Firms that can issue debt that is (nearly) default-risk free escape liquidity constraints caused by asymmetric information.

What if our firms have excess debt capacity but systematically operate below their optimal debt ratio? This could explain why they issue debt when they need external funds. However, if they are constantly below target over a 20-year sample period, the concept of an optimal debt ratio has little operational meaning. On the other hand, if many such firms were found to issue equity, the pecking order would be rejected.

The static tradeoff and pecking order theories assume shareholder wealth maximization as the corporate objective. We do not attempt to test any theory based on managerial or organizational objectives.[4] Such a theory could predict behavior similar to the pecking order.

But we are not attempting to frame or test a general model of capital structure choices. As Harris and Raviv's (1991) review article demonstrates, the motives and circumstances that could determine those choices seem nearly uncountable. Instead we concentrate on simple specifications of two widely cited theories. It's important to understand why tests of these specifications work, do not work, or appear to work.

1.2. Plan of the paper

Section 2 describes the two contending hypotheses. Data, basic tests and results are described in Section 3. Section 4 shows how the statistical power of models of financing can be assessed. The standard target adjustment model cannot be rejected when the pecking order drives financing. We *can* reject the

[4] Most of these theories follow from Jensen (1986). Harris and Raviv (1991) includes an encyclopedic survey of capital structure theories based on agency costs.

pecking order in a static tradeoff world. This section also comments on the power of certain cross-sectional tests. Section 5 concludes and discusses implications for future research.

2. Two simple models

2.1. The pecking order

In its simplest form, the pecking order model of corporate financing says that when a firm's internal cash flows are inadequate for its real investment and dividend commitments, the firm issues debt. Equity is never issued, except possibly when the firm can only issue junk debt and costs of financial distress are high.

Define

C_t = operating cash flows, after interest and taxes,
DIV_t = dividend payments,
X_t = capital expenditures,
ΔW_t = net increase in working capital,
R_t = current portion of long-term debt at start of period,[5]
D_t = long-term debt outstanding,
A_t = net book assets, including net working capital,[6]
d_t = D_t/A_t, the book debt ratio,

with all stock variables measured at the end of period t. The funds flow deficit is

$$DEF_t = DIV_t + X_t + \Delta W_t + R_t - C_t. \tag{1}$$

In the strict pecking order model, all components of the deficit are exogenous as long as safe debt can be issued. There is no incentive to move down the pecking order and issue stock.

The pecking order hypothesis to be tested is:

$$\Delta D_{it} = a + b_{\mathrm{PO}} DEF_{it} + e_{it}, \tag{2}$$

where ΔD_{it} is the amount of debt issued – or retired, if DEF_t is negative – by firm i. We expect $a = 0$ and $b_{\mathrm{PO}} = 1$. The pecking order coefficient is b_{PO}.

Eq. (2) is not an accounting identity because DEF_t does not include equity issues or repurchases. The simple pecking order predicts that the firm will only issue or retire equity as a last resort.

[5] We assume this amount has to be repaid during period t.

[6] Alternatively, A_t equals net total book assets less current liabilities. We are modeling long-term financing.

2.2. Asymmetric information and the pecking order

The pecking order is one implication of the Myers-Majluf (1984) analysis of how asymmetric information affects investment and financing decisions. That analysis has two main results. First, if costs of financial distress are ignored, the firm will finance real investment by issuing the safest security it can. Here 'safe' means 'not affected by revelation of managers' inside information'. In practice, this means that firms which can issue investment-grade debt will do so rather than issue equity.[7]

Second, if costs of financial distress are serious, the firm will consider issuing equity to finance real investment or pay down debt. It may forgo the issue if managers' information is sufficiently favorable and the issue price is too low. In that case, the debt ratio will remain uncomfortably high or real investment will be curtailed. However, less optimistic managers will issue equity.

Thus a broader pecking order hypothesis would accommodate some equity issues. It will be difficult to distinguish pecking order and static tradeoff predictions at high debt levels, and we do not attempt to do so in this paper. However, the possibility of equity issues under a more general pecking order stacks the deck against the stripped-down model tested in this paper. Equity issues at high debt levels will improve the fit of tradeoff models and degrade the fit of our simple pecking order specification.

The Myers-Majluf reasoning works in reverse when the company has a surplus ($DEF_t < 0$) and wants to return cash to investors.[8] If there are tax or other costs of holding excess funds or paying them out as cash dividends, there is a motive to repurchase shares or pay down debt. Managers who are less optimistic than investors naturally prefer to pay down debt rather than repurchasing shares at too high a price. The more optimistic managers, who are inclined to repurchase, force up stock prices if they try to do so. Faced with these higher stock prices, the group of optimistic managers shrinks, and the stock price impact of an attempted repurchase increases. If information asymmetry is the only imperfection, the repurchase price is so high that all managers end up paying down debt.

Thus the simple pecking order's predictions do not depend on the sign of DEF_t. In principle the firm could become a net lender if funds surpluses persist. Of course share repurchases could occur, even in a Myers-Majluf model, if there are significant tax or other costs of operating at a very low or negative debt ratio.

Because the pecking order is driven by asymmetric information, capital structure depends on the net requirement for external finance. No balance-sheet

[7] We know that investment-grade debt is safe, in the Myers-Majluf (1984) sense, because issuing it has, on average, no stock price effects. See Shyam-Sunder (1991).

[8] Compare the following discussion with Myers-Majluf (1984, pp. 207–209).

variables appear in Eq. (2). We do not actually believe that balance sheets are irrelevant. We expect firms to find ways to add equity when debt ratios are painfully high, and to reduce equity when they fall near zero or the firm is a net lender.[9] The nature of assets on the balance sheet is also important.[10] A 20% debt-to-assets ratio is low for commercial real estate but high for a high-tech startup.

Therefore the simplest version of the pecking order, expressed in Eq. (2), cannot be generally correct. It may, however, be a good description of financing over a wide range of moderate debt ratios.

2.3. A target adjustment model

The static tradeoff theory has managers seeking optimal capital structure. Random events would bump them away from it, and they would then have to work gradually back. If the optimum debt ratio is stable, we would see mean-reverting behavior.

The simple form of the target adjustment model states that changes in the debt ratio are explained by deviations of the current ratio from the target. The regression specification is

$$\Delta D_{it} = a + b_{\mathrm{TA}}(D^*_{it} - D_{it-1}) + e_{it}, \tag{3}$$

where D^*_{it} is the target debt level for firm i at time t. We take b_{TA}, the target-adjustment coefficient, as a sample-wide constant. The hypothesis to be tested is $b_{\mathrm{TA}} > 0$, indicating adjustment towards the target, but also $b_{\mathrm{TA}} < 1$, implying positive adjustment costs.

Unfortunately, the target is unobservable. One common response starts with the historical mean of the debt ratio for each firm, which can be multiplied by total capital to obtain an estimated target debt level. Alternative specifications include a rolling target for each firm, using only historical information, and an adjustment process with lags of more than one year. Jalilvand and Harris (1984) report that use of a three-year moving average does not alter their results.

Target adjustment models predict changes in debt ratios, which depend on the net amount of debt issued. The pecking order predicts gross debt issues, because repayment of the current portion of long-term debt is a required use of funds and therefore included in DEF_t. However, we can recast the pecking order as a predictor of net debt issues or changes in the debt ratio. We will test several specifications.

We have concentrated on the target adjustment specification of the static tradeoff theory because it matches up with the pecking order, which is naturally

[9] This is true considering only asymmetric information. Tax and agency issues supply many other reasons.

[10] See Smith and Watts (1992).

a time-series hypothesis, and because the apparent success of target-adjustment tests is widely cited. But our arguments also apply to cross-sectional tests of the static tradeoff theory. We return to cross-sectional tests in Section 4.

3. Basic tests

3.1. Sample and data

We started with all firms on the Industrial Compustat files. Financial firms and regulated utilities were excluded. Firms are included in the final sample if they have no gaps in data on the relevant funds-flow and balance-sheet variables and if they are not involved in a 'major' merger as defined in the Compustat footnotes.[11] Our requirement for continuous data follows previous tests of target-adjustment models;[12] tests of pecking order models only would not require continuous data.

Compustat includes flow of funds statements from 1971. This sets the starting point of our sample period, which extends to 1989. The requirement for continuous data on flow of funds (necessary for our simulation tests[13]) restricts our sample to 157 firms.[14] This procedure may bias our sample toward relatively large firms with conservative debt ratios, because small firms with unconservative debt ratios are more likely to drop out of the sample.

This bias towards larger firms, if it exists, does not affect the pecking order tests. The pecking order predicts the same financing behavior at all except the highest and lowest debt ratios.[15] However, such a bias might work against the target-adjustment specification of the static tradeoff hypotheses. If firms in the sample are generally below their optimal debt ratios – on the left of Fig. 1 – then their debt ratios should systematically increase in the sample period and

[11] Major mergers often trigger major, discontinuous shifts in capital structure, but neither of the theories tested in this paper predict that mergers are undertaken in order to change capital structure. Thus we excluded firms with major mergers from the sample.

[12] Jalilvand and Harris (1984), Titman and Wessels (1988) and Auerbach (1985) eliminated companies for which continuous data were not available.

[13] We have to simulate cumulative debt issues or retirements, as predicted for each firm by the pecking order model, in order to test the power of the target-adjustment hypothesis against the pecking order alternative. This simulation requires continuous data on flow of funds.

[14] Constructing funds flow statements using changes in balance sheets proved impossible because of inconsistencies in the reported data. Reconciling year-to-year statements was extremely difficult. We opted for a smaller sample for which funds flow data are available.

[15] However, our sample selection procedure may tend to exclude risky, growth firms that would be more likely to seek external equity financing at *low* debt ratios. This could enhance the performance of the stripped-down pecking order specification, which does not provide for stock issues.

not necessarily revert to the firms' time-series averages. We could find a positive constant and a poor fit in Eq. (3). But our results will show that the fitted constants of the target-adjustment models are close to zero, and the slope coefficients seem to imply rapid movement toward optimal capital structure.[16]

The analysis in this paper is restricted to book debt amounts and to book debt ratios, defined as the ratio of long-term debt to the book value of assets. As Myers (1977) has pointed out, there are rational reasons for managers to specify debt targets in terms of book values. Market values incorporate the present values of future growth opportunities. Debt issued against these values can distort future real investment decisions. But the choice of book debt ratios is not crucial, since we also use net or gross debt issues as dependent variables. We have also checked our results by scaling debt issues by sales rather than net book assets.

Table 1 summarizes the sample's debt ratios and other characteristics for three dates, 1971, 1981 and 1989. The mean debt ratio for the entire sample period was 0.18.

3.2. Results

Panel A of Table 2 summarizes the basic ordinary least squares (OLS) tests. The dependent variables are net and gross debt issued, scaled by book assets, and the change in the debt ratio.[17] Results for the basic target-adjustment model (Eq. (3)) are given in the first and fifth columns. As in Auerbach (1985) and Jalilvand and Harris (1984) we find constants close to zero,[18] and significant adjustment coefficients of $b_{TA} = 0.33$ (Column 1) and $b_{TA} = 0.41$ (Column 5). The targets are based on sample mean debt ratios for each firm. R^2s for the two specifications are 0.21 and 0.25, respectively. However, when the target is based on a three- or five-year rolling average of the book debt ratio up to the preceding year, the adjustment coefficients are not significant. These results are not reported.

The even-numbered columns in Panel A of Table 2 give results for the simple pecking order, Eq. (2). The results for gross debt issues, shown in the fourth column, are the most pertinent. The coefficient is $b_{PO} = 0.85$, which is the right order of magnitude, but significantly less than the simple pecking order

[16] We have 19 years' data for each firm in our sample. If firms languish for that many years below their optimal debt ratios, the static tradeoff model cannot have much practical relevance.

[17] Since we are concerned with long-term financing, the denominator of the debt ratio is total book capitalization, that is net long-term book assets plus net working capital. Net and gross debt issues are scaled by book assets only as a precaution against heterosckedasticity.

[18] This result suggests that our sample is not biased towards firms operating below their optimal debt ratios for most of the sample period. If there were such a sample bias, then, contrary to the results in Table 2, we should have found positive constants and low explanatory power.

Table 1
Descriptive statistics for a sample of 157 industrial firms for year endings 1971, 1981 and 1989. Data are taken from the Industrial Compustat tapes. The book debt ratio is the ratio of long term debt to the book value of assets. The book value of assets includes net working capital. Return on assets is the ratio of after-tax operating earnings to book value of assets. Dollar figures are in millions.

	1971	1981	1989
Book value of assets			
Mean	220	605	2034
Median	79	176	135
Maximum	10,509	23,021	160,893
Minimum	3	4	4
Market value of equity			
Mean	185	248	890
Median	136	143	790
Maximum	7,265	3,359	20,625
Minimum	2	3	2
Book debt ratio			
Mean	0.18	0.18	0.19
Median	0.17	0.13	0.17
Maximum	0.82	0.68	0.79
Minimum	0.00	0.00	0.00
Return on assets			
Mean	0.147	0.154	0.115
Median	0.136	0.149	0.123
Maximum	0.50	0.58	0.36
Minimum	− 0.22	− 0.60	− 0.31
Number of firms with tax loss carry forwards	23	16	28

prediction of 1.0. The R^2 is very high (0.86). Considering the simplicity of the model, the pecking order does very well.

The pecking order results show that external funding is dominated by debt. Indeed, for many individual firms, the R^2 and the coefficient estimates are exactly, or very close to, 1.0. Fig. 2 shows the firmwise distribution of R^2 for the simple pecking order model, fitted separately to each firm, over two periods, 1971–1984 and 1971–1989. Comparison of these two histograms hints that the pecking order hypothesis did less well in the last half of the 1980s. However, several of the low R^2s for 1971–1989 are for firms which undertook leveraged restructurings in the late 1980s.

The third and seventh columns of Panel A in Table 2 show what happens when the financing deficit and the target-adjustment mechanism are included in

Table 2
Regression results for target adjustment and pecking order models. The dependent variable is the gross or net annual amount of debt issued, scaled by the book value of assets, or the change in the debt-to-asset ratio. The target adjustment equations predict gradual adjustment to target ratios, where each firm's target is measured by its average debt ratio over 1971–1989. The target adjustment coefficient b_{TA} estimates the fraction of the distance between actual and target covered in one year. Pecking order equations predict debt issues (retirements) equal to each firm's financial deficit (surplus), implying a pecking order coefficient of $b_{PO} = 1$. Panel A gives Ordinary Least Squares Results. Panel B shows results from other specifications. Standard errors in parentheses. Except for the constant terms, all coefficients are significant at the 1% level.

Panel A. Dependent variable

	(1) Net debt issued/assets	(2) Net debt issued/assets	(3) Net debt issued/assets	(4) Gross debt issued/assets	(5) Change in debt ratio	(6) Change in debt ratio	(7) Change in debt ratio
Constant, a	0.003	0.002	−0.0004	0.001	−0.01	−0.002	−0.002
	(0.002)	(0.0009)	(0.0009)	(0.0008)	(0.002)	(0.001)	(0.008)
Target adjustment coefficient, b_{TA}	0.33		0.11		0.41		0.15
	(0.01)		(0.01)		(0.01)		(0.01)
Pecking order Coefficient, b_{PO}		0.75	0.69	0.85		0.80	0.73
		(0.01)	(0.01)	(0.01)		(0.01)	(0.01)
R^2	0.21	0.68	0.71	0.86	0.25	0.74	0.76

Panel B. Alternative specifications. Dependent variable is the change in debt ratio

	Variance components model			First order serial correlation with contemporaneous cross-sectional correlation			Dummy variables for each year		
Constant, a	−0.001 (0.001)	−0.001 (0.001)	−0.001 (0.001)	0.0001 (0.001)	−0.002 (0.000)	−0.002 (0.001)	0.0001 (0.001)	−0.001 (0.001)	−0.001 (0.001)
Target adjustment coefficient, b_{TA}	0.26 (0.01)		0.10 (0.01)	0.32 (0.01)		0.13 (0.01)	0.32 (0.02)		0.12 (0.01)
Pecking order coefficient, b_{PO}		0.76 (0.01)	0.72 (0.01)		0.76 (0.01)	0.71 (0.01)		0.75 (0.01)	0.72 (0.01)
R^2	0.13	0.67	0.72	0.15	0.75	0.76	0.14	0.74	0.75

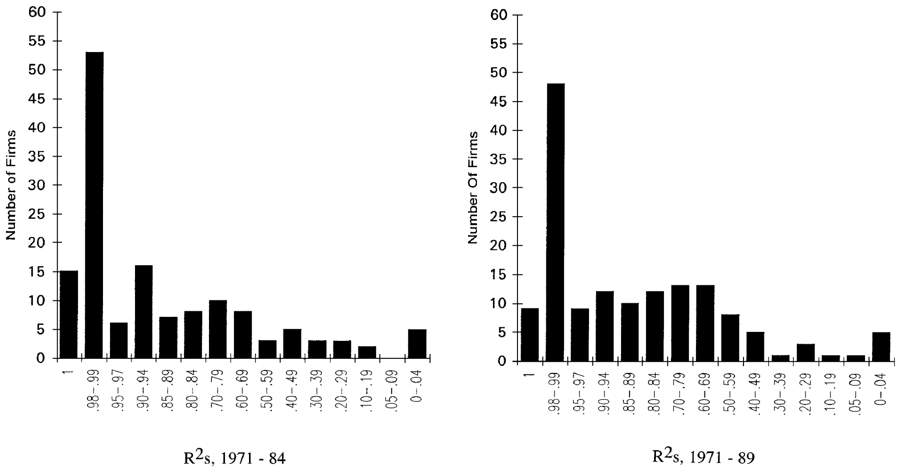

Fig. 2. Frequency distributions of R^2s from fitting the basic pecking order equation to each firm in the sample. The equation is $\Delta D_{it} = a_i + b_i DEF_{it} + e_{it}$, where ΔD_{it} is the change in gross debt issued, and DEF_{it} is the financial deficit for firm i. This equation corresponds to Eq. (2), except that the constant a_i and the pecking order coefficient b_{PO} vary firm by firm. ΔD_{it} and DEF_{it} are scaled by book assets.

the same equation. The target adjustment coefficients drop to less than a third of the values in column one. This does not disprove the target adjustment hypothesis, since the t-statistic is still very high. (We defer issues of statistical power until the next section.) However, the magnitude and significance of the coefficients for the pecking order model are basically unchanged.

We re-ran all of the tests in Panel A of Table 2 involving gross and net debt issues with variables scaled by sales instead of book assets. The results were virtually identical. We also ran tests using deficits, debt issues and changes in debt ratios cumulated over a varying number of years. We corrected for first-order serial correlation and included firm-specific dummy variables. None of these variations were inconsistent with the results already described. However, an attempt to estimate firm-specific target adjustment coefficients (b_{TA}) yielded extremely poor fits.

We ran three other statistical specifications using the change in the debt ratio as the dependent variable. We estimated a variance components model with two-way random effects as in Fuller and Battese (1974); included a time dummy variable, following Da Silva (1975), and estimated a first-order autoregressive model with contemporaneous correlation as in Parks (1967). The results are given in Panel B of Table 2. The target adjustment coefficient, b_{TA}, and the target-adjustment R^2 are lower than in Panel A. The pecking order coefficient and R^2 also fall, but to a lesser extent. Standard errors increase, but coefficients remain highly significant. We also ran a fixed-effects model, with closely similar results.

The story so far is as follows. First, a simple target-adjustment model provides some explanatory power for changes in debt ratios, and its coefficients look reasonable and are statistically significant. However, a simple pecking order model has much better explanatory power.

3.3. Anticipated vs. actual deficits

We should consider whether the good fit of the pecking order specification has more to do with short-term adjustments than planned financing. Note that the pecking order regressions relate debt issues or retirements to contemporaneous deficits, including cash inflows or outflows which may be mid- or late-year surprises. Suppose we break out the surprises:

$$DEF_t = E_{t-1}[DEF_t] + Z_t, \tag{4}$$

where $E_{t-1}[DEF_t]$ is the expected deficit at the end of year $t-1$ and Z_t is the net unexpected funds inflow or outflow. Z_t might be a good predictor of debt changes if it is difficult to issue or retire equity on short notice. This is consistent with the pecking order – information asymmetries provide one good reason why equity is not issued on short notice – but that theory is more convincing if companies also *plan* to cover deficits by issuing debt.

We cannot observe $E_{t-1}[DEF_t]$, and so have to find an instrument. We use two: (1) the deficit lagged one year, DEF_{t-1}, and (2) a predicted deficit using lagged values for funds from operations and changes in net working capital, but otherwise contemporaneous flows. Use of instrument (2) assumes that the other components of DEF_t, such as capital expenditures and dividends, are planned by management at the end of year $t-1$, and that year t's surprises are confined to funds from operations and changes in working capital. Use of instrument (1) hopes that there is enough serial correlation in individual firms' deficits that the lagged deficit is a decent predictor of the deficits forecasted by managers.

Panel A of Table 3 shows OLS pecking order results for gross debt issues using these two instruments. The pecking order coefficients and explanatory power naturally drop somewhat when the instruments are used alone, since they measure the true anticipated deficits with error. Use of the lagged deficits gives a pecking order coefficent of $b_{PO} = 0.64$ and $R^2 = 0.64$. Use of deficits with lagged funds from operations gives $b_{PO} = 0.78$ and $R^2 = 0.78$. Constants stay very close to zero, as predicted by the pecking order specification.

When the change in operating funds and net working capital is added to the regressions, the explanatory power improves as expected. However the significance of the instruments for the planned deficit are scarcely changed, indicating that the high explanatory power of our simple pecking order model is not driven merely by short-term adjustments to unanticipated financing deficits or surpluses.

Table 3
Regression results for target adjustment and pecking order models. The specification matches Panel A of Table 2, except that insruments are used for the anticipated deficit. The instruments are the lagged deficit, DEF_{it-1}, and the deficit calculated using funds from operations, including changes in net working capital, lagged one period. All variables are scaled by book assets. Except for constant terms, all variables are signficiant at the 1% level.

Panel A. Dependent variable: Gross debt issued				
Constant, a	0.001	0.002	0.007	0.007
	(0.001)	(0.0009)	(0.0007)	(0.0008)
Coefficient (b_{PO}) on lagged deficit, DEF_{it-1}	0.64	0.64		
	(0.01)	(0.01)		
Coefficient on change in deficit, $DEF_{it} - DEF_{it-1}$		0.17		
		(0.01)		
Coefficient (b_{PO}) on deficit with lagged funds from operations[a]			0.78	0.78
			(0.01)	(0.01)
Coefficient on change in funds from operations from $t-1$ to t				0.04
				(0.01)
R^2	0.64	0.81	0.78	0.80
Panel B. Dependent variable: Net debt issued				
Constant, a	0.0001	0.0001	0.0001	0.0008
	(0.0004)	(0.0008)	(0.0007)	(0.0008)
Target adjustment coefficient, b_{TA}	0.19	0.13	0.11	0.11
	(0.01)	(0.01)	(0.01)	(0.01)
Coefficient (b_{PO}) on lagged deficit, DEF_{it-1}	0.54	0.54		
	(0.01)	(0.01)		
Coefficient on change in deficit, $DEF_{\mathrm{it}-1} - DEF_{it-1}$		0.16		
		(0.01)		
Coefficient (b_{PO}) on deficit with lagged funds from operations[a]			0.61	0.61
			(0.01)	(0.01)
Coefficient on change in funds from operations from $t-1$ to t				0.06
				(0.01)
R^2	0.53	0.71	0.62	0.72

Panel B of Table 3 nests the target adjustment and pecking order models using the two instruments for the anticipated deficit. Once again, the target adjustment coefficient is significant, although its magnitude is considerably lower than the pecking order variable. Adjusted R^2s decrease from Panel A.

No doubt better models for the anticipated deficit could be constructed. However, Table 3 demonstrates that the high explanatory power of the pecking order is not driven by impediments to equity issues or retirements on short notice.

4. Power

The tests reported so far show that when the target-adjustment and pecking order models are independently tested against a zero null, they both appear to describe the variation in debt ratios, although the pecking order wins the horse race when judged on raw explanatory power (R^2). We now investigate the statistical power of these tests. We demonstrate that the target-adjustment model can generate plausible and highly 'significant' statistical results *even when it is false*. The simple pecking order test does not suffer from this lack of power. It is correctly rejected when it is false.

4.1. Method

Statistical power is often investigated using Monte Carlo simulation on hypothetical data. In this case we start with the actual investment outlays and operating results of our sample companies. We then generate hypothetical time series of debt issues or retirements, one series for each of the 157 sample companies, using either the target adjustment model, Eq. (3), or the pecking order model, Eq. (2). For example, a hypothetical pecking order regime forces the firm to issue only debt when there is a financial deficit, and to use every dollar of financial surplus for debt reduction. A time series of debt ratios can be computed assuming these financing rules. An alternative series of debt ratios can be generated, assuming the firm follows a target-adjustment rule with specified adjustment coefficients.

For each model we then have 157 simulated debt financing histories, each spanning 19 years. If the assumed financing model is correct, the histories must be realistic, since they are based on actual real investment and operating data. "Realistic" means that debt issues or retirements (or changes in debt ratios) have the same means, trends, variances, correlations and time patterns as would have been observed for actual firms under the assumed financing hypotheses.

The tests summarized in Panel A of Table 2 are then run independently on each of these financing histories. If the tests have statistical power, we should reject the pecking order model for the histories generated by the target adjustment model. Likewise, we should reject the target adjustment model when it is fitted to series generated by the pecking order.

We will show that the pecking order specification is correctly rejected in all cases where an alternative financing rule is simulated. The target-adjustment specification is biased toward acceptance even when firms follow strict pecking order rules.

4.2. Generating the financing time series

Before presenting numerical results, we describe in more detail how the simulated financing histories were generated.

4.2.1. Pecking order

We started with 1971 year-end values for each firm's book debt ratio. Later years' book debt ratios were then generated by determining the funds flow deficit, using actual data for operating cash flow,[19] real investment, dividends, etc. The firm is assumed to issue debt if the deficit is positive and retire debt if it is negative.[20] The predicted debt ratio for the end of the year is computed. The debt ratio for the next period is generated in the same way, except that a proportion of the simulated debt level of the previous year has to be repaid. This process is continued to generate a series of book debt ratios for each firm from 1971 to 1989. This series tells us what the path of book debt ratios would be for each firm if, starting in 1971, it had followed a strict pecking order.

4.2.2. Target-adjustment model, with target set at historical average

We again started with the 1971 year-end value of the book debt ratio. Ratios for later years were simulated according to the basic target adjustment model, Eq. (3). Each firm's target was proxied for by the actual historical mean book debt ratio from 1971 to 1989. This corresponds to specifications used in Taggart (1977), Jalilvand and Harris (1984) and Marsh (1982). We report results for the hypothetical series generated using an adjustment coefficient of $b_{\mathrm{TA}} = 0.4$ (the empirical estimates of the adjustment coefficient in Table 2 are 0.33 and 0.41) and a serially uncorrelated error with annual standard deviation of 0.10. This series tells us what the book debt ratios would be for each firm if, starting in 1971, it had followed a target adjustment rule with these parameters.

Of course the static tradeoff theory doesn't require any particular numerical value for the adjustment coefficient $\mathrm{b_{TA}}$. Therefore we varied the adjustment coefficient from 0.1 to 1.0 (but constrained it to be the same for each firm) and varied the standard deviation of the error term from 0 to 0.2. Our results are robust over these ranges except at very low values of b_{TA}.

There is no practical or theoretical reason to think that a firm's target debt ratio would stay constant over a 19-year period. Even if it did, the historical mean debt ratio would not measure the target exactly. We therefore generated a third set of simulated financing histories. In this case each firm's target was calculated from firm characteristics used in prior cross-sectional studies of capital structure.

[19] We used actual operating cash flows, after interest and taxes, as in Eq. (1). We did not recalculate interest and taxes under the hypothetical financing policies. Thus our assumed pre-tax, pre-interest operating cash flows are not quite true to real life. This does not affect the tests of statistical power reported in Table 4.

[20] We also developed time series of debt ratios assuming that funds surpluses were not used to pay down debt but instead were held as cash. The results reported in Table 4 below were basically unchanged.

4.2.3. Target-adjustment model, with target determined by firm characteristics

Static tradeoff models maintain that a firm's optimal debt ratio is a function of risk, asset type, tax status and profitability. One example is

$$d_{it} = a + b_1(Plant_t) + b_2(R\&D_t) + b_3(Tax_t) + b_4(Earnings_t), \tag{5}$$

where Plant is the ratio of plant and equipment to sales or assets, a proxy for fixed assets; *R&D* is the ratio of research and development expenditures to sales or assets, a proxy either for intangible assets or growth opportunities; *Tax* is the ratio of taxes paid to sales or assets, a proxy for the tax-paying status of the firm, and *Earnings* is the ratio of operating earnings to sales or assets, a proxy for profitability.

We used Eq. (5) to calculate changes in each firm's target. This allowed the targets to vary year by year, as well as firm by firm, though for most sample companies the targets did not vary much over time.

One can easily think of other proxies. The static tradeoff theory does not specify them, and the literature has employed a wide range of variables. We have checked several alternative specifications. Eq. (5) is given only as an example.

The simulated debt ratio series were generated by using the 1971 value of the book debt ratio of each firm as the seed value, and then generating the subsequent values as:

$$\Delta d_{it} = 0.3\Delta(Plant_t) - 0.2\Delta(R\&D_t) + 0.2\Delta(Tax_t) + 0.3\Delta(Earnings_t). \tag{6}$$

We believe these coefficients are plausible, but they were not matched to any particular empirical study.

4.3. The fitted models

Panel A of Table 4 shows results for the pecking order specification. The column headed 'Actual data' repeats the coefficients from Table 2. Column (2) reports coefficients for the simulated financing histories based on the target-adjustment model with targets equal to historical averages. Column (3) matches (2) except that targets are calculated from Eq. (6).[21] The pecking order fits the actual data well, but has no significance or explanatory power for the simulated data based on the target-adjustment specifications. We infer that our tests have the power to reject the pecking order and that the fit to real data is probably not spurious.

Panel B shows the results of fitting the target-adjustment specification. Remember, this assumes a constant target debt ratio for each sample firm. As reported earlier, it fits actual data well, with plausible and significant

[21] Column 1 is of course blank – there's no point fitting the pecking order equation to data generated by the same equation. Column 2 is blank in Panel B for the same reason.

Table 4
Results of fitting the pecking order and target adjustment models to actual and simulated data for 157 firms from 1971 to 1989. Panel A estimates the pecking order equation

$$\Delta D_{it} = a + b_{\mathrm{PO}}\, DEF_{it} + e_{it},$$

where ΔD_{it} is the amount of debt issued by firm i in period t, DEF_{it} is the internal cash flow deficit and b_{PO} is the pecking order coefficient. The model is estimated using actual debt ratios, and simulated debt ratios assuming target adjustment with a fixed target (Column 2) and a 'moving target' based on firm characteristics (Column 3). The dependent variable is the change in the book debt to assets ratio. Panel B estimates the target adjustment equation

$$\Delta D_{it} = a + b_{\mathrm{TA}}(D^*_{it} - D_{it-1}) + e_{it}$$

on actual debt ratios, and simulated debt ratios assuming a pecking order (Column 1) and a moving target (Column 3). Panel C estimates both models combined using actual debt ratios, and simulated debt ratios assuming a pecking order (Column 1) and target adjustment with a fixed target (Column 2).
Standard errors of coefficients are in parentheses.

	Actual data	Simulated data		
		(1) Pecking order	(2) Target adjustment (fixed target)	(3) Target adjustment (moving target)
Panel A: Pecking order model				
Constant, a	– 0.01		0.00	0.00
	(0.01)		(0.00)	(0.00)
Pecking order coefficient b_{PO}	0.84		0.02	– 0.13
	(0.01)*		(0.01)	(0.01)
R^2	0.75		0.02	0.05
Panel B: Target adjustment model				
Constant, a	– 0.01	– 0.05		0.01
	(0.07)	(0.01)*		(0.01)
Target adjustment coefficient b_{TA}	0.30	0.23		0.42
	(0.02)*	(0.01)*		(0.20)
R^2	0.15	0.12		0.20
Panel C: Both models combined				
Constant, a	– 0.01	0.01	0.01	
	(0.07)	(0.01)*	(0.01)*	
Pecking order coefficient	0.72	1.02	0.01	
	(0.01)*	(0.01)*	(0.02)	
Target adjustment coefficient	0.10	0.07	0.59	
	(0.01)*	(0.01)*	(0.02)*	
R^2	0.72	0.65	0.34	

An asterisk indicates significance at the 1% confidence level.

coefficients. The coefficients and t-statistics reported in Column (3) (where the changes in simulated debt ratios depend on firm characteristics) are likewise fine. The surprise is in Column (1): the target-adjustment specification fits the simulated pecking order series just as well as the actual data! This is clearly a false positive.

Panel C nests the two specifications. For this purpose we added an error term to each firm's simulated pecking order financing. Otherwise the pecking order coefficient b_{PO} would have been hard-wired at 1.0 when the nested specification was fitted to the pecking order simulations. In Column (2) we see that the pecking order is still rejected when financing follows the target adjustment model; the coefficients in Panels A and C are nearly identical. But in Column (1) the target adjustment coefficient falls from 0.23 to 0.07 when the pecking order variable is added. An almost identical proportional fall occurs in the target-adjustment coefficient for the actual data. But the coefficient is still highly significant: we cannot reject the target-adjustment hypothesis in the nested model, even when financing is generated only by the pecking order.

We infer that the usual tests of the target-adjustment model lack power and that the model's coefficients for actual data are, for this sample at least, spuriously significant.

Why does the target adjustment model appear to explain financing decisions when underlying behavior is purely pecking order? There is a simple answer: fluctuations in the sample companies' capital expenditures are positively serially correlated, and their operating earnings are cyclical. Since dividends are 'sticky', and not used as a short-run offset to net funds requirements, the companies tend to have strings of years with financial deficits, followed by strings of surpluses, or vice versa. Under the pecking order, the debt ratio climbs in deficit years and falls in surplus years. When the average debt ratio, measured ex post, is taken as the target, the pecking order debt ratios show mean-reversion.[22] Thus the target adjutment models generate a misleadingly good fit.[23]

Shyam-Sunder (1988) confirmed this interpretation by extensive simulations of hypothetical firms' investment, operating and financing policies. The pecking order was assumed to work exactly. Nevertheless, target-adjustment models appeared to work when dividends adjusted slowly, when capital expenditures came in two- or three-year blocks, or when operating income was cyclical or mean-reverting.

[22] The target-adjustment also model gave a positive and significant value for b_{TA} when fitted to debt ratios simulated as random walks! (We assumed reflecting barriers at 0 and 1.0.) This is one more illustration of the false positives introduced by using an ex post mean as the target.

[23] As we noted above, the target-adjustment model's fit to actual data falls apart when a three- or five-year rolling average is used as the debt target. In other words, the model seems to work for this sample *only* because of the apparent mean reversion generated by use of an ex post historical average debt ratio.

In short, there is mean-reversion in the sample companies' debt ratios. But this does not mean that the companies were issuing or retiring debt to move toward an optimal target debt ratio. If they had been doing so, the pecking order specification would have been rejected: the experiments summarized in Table 4 show that the stripped-down pecking order specification can be rejected if companies actually follow a target adjustment financing rule.

Mean reversion in debt ratios can generate spuriously good fits, and significant coefficients for target-adjustment models, even when the mean reversion has nothing to do with optimal debt ratios, but simply reflects pecking-order financing coupled with cycles or mean-reversion in financial deficits or surpluses.

4.4. A comment on cross sectional tests

The results so far strongly increase our confidence in the pecking order against the target-adjustment model, at least for our sample of mature public companies. However, our specification of the static tradeoff theory is only one of several possible treatments and interpretations. The literature also contains several cross-sectional studies relating leverage to proxies for the determinants of the optimal debt ratio. Harris and Raviv (1991, p. 334) say that '[t]hese studies generally agree that leverage increases with fixed assets, nondebt tax shields, growth opportunities, and firm size and decreases with volatility, advertising expenditures, research and development expenditures, bankruptcy probability, profitability and uniqueness of product'. Examples of such studies include Bradley et al. (1984), Kester (1986), Long and Malitz (1985) and Baskin (1985), who test the tradeoff theory using cross-sectional regressions of debt ratios against various proxy variables.

The power of such tests against the alternative pecking order hypothesis can be determined by the same methods used to generate Table 4. The cross-sectional model would be fitted to actual data, and to firm-by-firm financing histories simulated using the pecking order rule. If the cross-sectional tests have power, the model should fail when run on the simulated data. If it does not fail, then tests on actual data do not have power to reject. We emphasize again that the simulations would apply to the actual sample companies – not hypothetical ones – and would be based on actual operating results, investments and dividends. Only the financing would be simulated.

A detailed examination of cross-sectional models is left to another paper. However, one example is useful to show that our concerns about power carry over to cross-sectional tests.

The example is summarized in Table 5. Each company's average debt ratio was related to firmwise averages of four variables. In this example, they are the amount of tax-loss carryforward, R&D, Plant and Earnings, each scaled by the book value of assets and averaged over the 19-year sample period. One

Table 5
Results of estimating a cross-sectional static trade off model $d_i = a_i + b_i X_i, + e_i$, where d_i is the debt ratio for firm i and X_i is a vector of explanatory variables. The model is estimated on actual debt ratios, and on simulated debt ratios generated by pecking order financing. Simulated and actual data are for 157 firms from 1971 to 1989. The dependent variable is the average book debt ratio for each firm over 1971 to 1989. Independent variables are from the Industrial Compustat tapes and are also averaged for each firm over 1971 to 1989. Explanatory variables are scaled by book value of assets. t-statistics are in parentheses. An asterisk indicates significance at the 1% level.

	(1) Actual data	(2) Pecking order simulation
Constant, a_i	0.15	0.14
	(5.15)*	(4.11)*
Coefficient b_i on		
Tax loss carry forward/assets	0.02	0.09
	(0.12)	(0.59)
R&D/assets	– 0.63	– 0.10
	(– 1.80)	– (0.25)
Plant/assets	0.29	0.35
	(7.79)*	(7.90)*
Earnings/assets	– 0.71	– 0.75
	(– 4.74)*	(– 4.23)*
R^2	0.38	0.37

cross-sectional regression was run for actual average debt ratios of the 157 sample companies, and another for the average ratios generated by the simulated pecking-order financial histories used to generate Panel B of Table 4.

Both Plant/Assets and Earnings/Assets show up with significant coefficients when the model is fitted to actual average debt ratios. A researcher looking only at Column (1) of Table 5 would see a tendency for companies with more tangible assets to borrow more, and for more profitable companies to borrow less. But look at Column (2): almost exactly the same coefficients and significance levels are obtained when the cross-sectional model is fitted to the simulated pecking-order data. Therefore the power of this cross-sectional test is questionable.

We ran several variations of Table 5 with essentially the same results, but since this paper does not go deeply into cross-sectional models, we do not report the results here.[24]

[24] For example, we scaled by sales rather than book assets; we estimated separate regression equations for each year, and we estimated a version of Auerbach's (1985) model. In all cases we found significant coefficients that could be read as supporting the static tradeoff theory – but we found these coefficients for simulated as well as actual data.

The essential point is this: check power before drawing conclusions. A firm could be following a pure pecking order, not driven at all by conventional tradeoff considerations, yet cross-sectional tests using reasonable proxies may suggest at least partial acceptance of the tradeoff theory of capital structure. This underscores our theme that tests of the traditional theories of capital structure against a zero null are not persuasive evidence.

We have demonstrated how to check the power of tests of hypotheses about capital structure. Modern theories state that financing choices are driven by earnings, growth opportunities, requirements for external financing and the types and values of assets. Start with these inputs *for actual firms* and simulate their financing histories under two or more hypotheses. Then test whether each hypothesis could be rejected if financing were generated by an alternative.

5. Conclusions

This study reexamines some aspects of the empirical literature on capital structure. Others, for example Titman and Wessels (1988), have attempted to test various models by including all hypotheses jointly in the empirical tests. Instead, we view the theories as contending hypotheses and examine their relative explanatory power. The attention to statistical power is an important methodological point, and we believe our procedure for testing the power of financing hypotheses is original.

Our main empirical results can be summarized as follows. (1) The pecking order is an excellent first-order descriptor of corporate financing behavior, at least for our sample of mature corporations. (2) The simple target adjustment model, when tested independently, also seems to perform well. (3) When the two models are tested jointly, the coefficients and significance of the pecking order models change hardly at all; the performance of the target-adjustment model degrades, though coefficients still appear statistically significant. (4) The strong performance of the pecking order does not occur just because firms fund unanticipated cash needs with debt in the short run. Our results suggest that firms plan to finance anticipated deficits with debt. (5) Our simulation experiments show that the target-adjustment models are not rejected even when false. The pecking order, when false, can be easily rejected. Thus our tests have power with respect to the pecking order.

Overall, the results suggest greater confidence in the pecking order than in the target adjustment model. If our sample companies did have well-defined optimal debt ratios, it seems that their managers were not much interested in getting there.

Two caveats are in order. First, we doubt the pecking order would do as well for a sample of growth companies investing heavily in intangible assets. Second, our models are very simple. For example, our experiments have considered only a few specifications of the tradeoff theory of optimal capital structure. Richer specifications have been, or could be, tested, for example some of the variations in Jalilvand and Harris (1984), and in Fischer et al. (1989), which allow for adjustment coefficients to vary by firm and relate them to the costs and benefits of deviation from targets. Fischer et al. (1989) also develop a dynamic, inventory-adjustment model of capital structure that could be more realistic than ordinary target-adjustment models.

Nevertheless, this paper shows that sharper models are called for. Empirical work on capital structure must devise tests of hypotheses that can be rejected. This is a challenge to both theoretical and empirical research.

References

Auerbach, A.S., 1985. Real determinants of corporate leverage. In: Friedman, B.M. (Ed.), Corporate Capital Structures in the United States. University of Chicago Press, Chicago, IL.

Baskin, J., 1985. On the financial policy of large mature corporations. Unpublished Ph.D. dissertation. Harvard University, Cambridge, MA.

Bradley, M., Jarrell, G.A., Kim, E.H., 1984. On the existence of an optimal capital structure: Theory and evidence. Journal of Finance 39, 857–878.

Da Silva, J.G.C., 1975. The analysis of cross-sectional time series data. Unpublished Ph.D. dissertation. North Carolina State University, Raleigh.

Fazzari, S., Hubbard, G., Petersen, B., 1988. Financing constraints and corporate investments. Brookings Papers on Economic Activity 1, 141–206.

Fischer, E., Heinkel, R., Zechner, J., 1989. Dynamic capital structure choice: theory and tests. Journal of Finance 44, 19–40.

Fuller, W.A., Battese, G.E., 1974. Estimation of linear models with crossed-error structure. Journal of Econometrics 2, 67–78.

Harris, M., Raviv, A., 1991. The theory of capital structure. Journal of Finance 46, 297–355.

Hoshi, T., Kashyap, A., Scharfstein, D., 1991. Corporate structure, liquidity, and investment: evidence from Japanese industrial groups. Quarterly Journal of Economics 56, 33–60.

Jalilvand, A., Harris, R.S., 1984. Corporate behavior in adjusting to capital structure and dividend targets: an econometric study. Journal of Finance 39, 127–145.

Jensen, M.C., 1986. Agency costs of free cash flow, corporate finance and takeovers. American Economic Review 76, 323–329.

Kester, C.W., 1986. Capital and ownership structure: a comparison of United States and Japanese manufacturing corporations. Financial Management 15, 97–113.

Long, M.S., Malitz, E.B., 1985. Investment patterns and financial leverage. In: Freidman, B. (Ed.), Corporate Capital Structures in the United States. University of Chicago Press, Chicago, IL.

Mackie-Mason, J., 1990. Do taxes affect corporate financing decisions? Journal of Finance 45, 1471–1494.

Masulis, R.W., 1980. The effects of capital structure change on security prices: a study of exchange offers. Journal of Financial Economics 8, 139–177.

Marsh, P., 1982. The choice between equity and debt: an empirical study. Journal of Finance 37, 121–144.

Miller, M.H., Modigliani, F., 1966. Some estimates of the cost of capital to the electric utility industry, 1954-57. American Economic Review 57, 333–391.

Myers, S.C., 1977. Determinants of corporate borrowing. Journal of Financial Economics 5, 147–175.

Myers, S.C., 1984. The capital structure puzzle. Journal of Finance 39, 575–592.

Myers, S.C., Majluf, N., 1984. Corporate financing and investment decisions when firms have information investors do not have. Journal of Financial Economics 13, 187–221.

Opler, T.C., Titman, S. 1994. The debt-equity choice: an analysis of issuing firms. Unpublished working paper. Boston College, Boston, MA.

Parks, R.W., 1967. Efficient estimation of a system of regression equations when disturbances are both serially and contemporaneously correlated. Journal of the American Statistical Association 62, 500–509.

Rajan, R.G., Zingales, L., 1995. What do we know about capital structure? Some evidence from international data. Journal of Finance 50, 1421–1460.

Ross, S.A., 1977. The determination of financial structure: the incentive signalling approach. Bell Journal of Economics 8, 23–40.

Schwartz, E., Aronson, R., 1967. Some surrogate evidence in support of the concept of optimal financial structure. Journal of Finance 22, 10–18.

Smith, C.W., Watts, R.L., 1992. The investment opportunity set and corporate financing, dividend, and compensation policies. Journal of Financial Economics 32, 263–292.

Shyam-Sunder, L., 1988. Essays in corporate financing. Unpublished Ph.D. dissertation. MIT, Cambridge, MA.

Shyam-Sunder, L., 1991. The stock price effect of risky versus safe debt. Journal of Financial and Quantitative Analysis 26, 549–558.

Taggart, R.A., 1977. A model of corporate financing decisions. Journal of Finance 32, 1467–1484.

Titman, S., Wessels, R., 1988. The determinants of capital structure choice. Journal of Finance 43, 1–19.

Whited, T., 1992. Debt, liquidity constraints, and corporate investment: evidence from panel data. Journal of Finance 47, 1425–1460.