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# Testing static tradeoff against pecking order models of capital structure: a critical comment<sup>☆</sup>

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## Abstract

In a recent paper, Shyam-Sunder and Myers (1999) introduce a new test of the Pecking Order Model. This comment shows that their elegantly simple test generates misleading inferences when evaluating plausible patterns of external financing. Our results, coupled with the power problem with the Static Tradeoff Model documented by Shyam-Sunder and Myers, indicate that their empirical evidence can evaluate neither the Pecking Order nor Static Tradeoff Models. Alternative tests are needed that can identify the determinants of capital structure and can discriminate among competing hypotheses. © 2000 Elsevier Science S.A. All rights reserved.

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## 1. Introduction

Capital structure remains enigmatic. Following on the famous irrelevance result of Modigliani and Miller (1958), most theories have sought to explain capital structure by introducing frictions omitted in the original Modigliani and Miller framework. In the Static Tradeoff Model (Myers, 1977), two frictions, the agency costs of financial distress and the tax-deductibility of debt finance, generate an optimal capital structure. An alternative model (Myers and Majluf, 1984) emphasizes frictions due to asymmetric information between managers and outside investors. In this Pecking Order Model, a financial hierarchy descends from internal funds, to debt, to external equity.

In a recent paper, Shyam-Sunder and Myers (1999) assess these non-nested capital structure models by examining debt financing patterns through time. They show that, under the Pecking Order Model, a regression of debt financing on the firm's deficit-of-funds, i.e., real investment and dividend commitments less internal funds, should yield a slope coefficient close to unity. For 157 U.S. firms during the period from 1971–1989, Shyam-Sunder and Myers find that this hypothesis is sustained. Furthermore, they evaluate the ability of their test to discriminate against a prominent alternative model of capital structure, the Static Tradeoff model. For this and several other reasons, Shyam-Sunder and Myers believe that the data favor the Pecking Order Model.

This comment demonstrates that Shyam-Sunder and Myers' elegantly simple test of the Pecking Order Model suffers from an important shortcoming. Section 2 presents a graphical treatment of their test. Section 3 considers three plausible patterns of external financing, and raises serious questions about the validity of inferences based on Shyam-Sunder and Myers' new testing strategy.

## 2. Testing the pecking order model of capital structure

The central friction in the Pecking Order Model of capital structure is the asymmetric information between managers and less-informed outside investors. Myers and Majluf (1984) show how this asymmetry leads firms to prefer internal funds to external funds. When the former are exhausted and there exists a deficit in funds, firms will prefer safer debt to riskier equity. Thus, there exists a financial hierarchy descending from internal funds, to debt, to external equity. Funds are raised through equity issues only after the capacity to issue debt has been exhausted.

The test advanced by Shyam-Sunder and Myers is based on the implication that, under the Pecking Order Model, a substantial amount of intertemporal variation in net debt issue ( $\Delta D$ ) should be explained by a single variable, the deficit-in-funds (DEF). The DEF variable is defined as capital expenditures, dividend payments, the net increase in working capital, and the current portion

of long-term debt (at the start of the period) less operating cash flows, after interest and taxes (Shyam-Sunder and Myers, 1999, p. 224). The testing strategy relies on the following elegantly simple model,

$$\Delta D_{it} = a_{PO} + b_{PO}DEF_{it} + e_{it}, \quad (1)$$

where  $i$  represents firms,  $t$  represents time,  $e_{it}$  is an error term, and  $a_{PO}$  and  $b_{PO}$  are parameters. Note that, in the Pecking Order Model, time-series variation is key to estimating the parameters. Eq. (1) is not an identity because net equity issues are absent. Indeed, the appearance of equity issues at the bottom of the financial hierarchy is the central element in the empirical testing strategy. The strong form test of the Pecking Order Model is that firms meet their deficit-in-funds by relying only on debt finance, and the associated null hypothesis is  $a_{PO} = 0$  and  $b_{PO} = 1$  (p. 224).

The strong form test is very restrictive, and hence will not be very useful in evaluating the Pecking Order Model. This test is likely to indicate rejection if the firm goes to the equity market for new capital. The capacity to issue debt will be curtailed at sufficiently high leverage ratios by the costs of financial distress and, at this point, firms must resort to equity issues. To accommodate this behavior, the test of the Pecking Order Model can be recast in a semi-strong form, which states that firms meet their deficit-in-funds by relying initially and primarily on debt finance. Trips to the equity market are both a rarity and a last resort. The semi-strong form test of the Pecking Order Model does not yield a precise null hypothesis, but implies that  $b_{PO}$  will be less than but close to unity [See Shyam-Sunder and Myers (1999), Section 2.2].<sup>1</sup>

Eq. (1) was estimated for 157 U.S. firms during the period from 1971–1989. The Pecking Order Model is identified by time-series variation, and the parameter estimates are very similar if estimated with the pooled model (containing both cross-section and time-series variation) or random-effects and fixed-effects models (containing only time-series variation). The constant,  $a_{PO}$ , is close to zero in both statistical and economic terms. The slope parameter,  $b_{PO}$ , ranges from 0.75 to 0.85 depending on the estimation technique and dependent variable, and is precisely estimated with a standard error of 0.01 [see Shyam-Sunder and Myers (1999): Table 2.A, Columns 2, 4, 6 and Table 2.B, Columns 2, 5, 8]. The range of parameter estimates is consistent with the semi-strong form test of the Pecking Order Model. Despite the parsimonious specification, the Pecking Order Model has substantial explanatory power, with  $R^2$ 's ranging from 0.67 to

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<sup>1</sup> The slope parameter, rather than the constant term, is key to evaluating the Pecking Order Model. While a non-zero constant suggests rejection, this result is a thin reed upon which to evaluate the test. If there are omitted variables that influence debt issue and have a non-zero mean, then the constant can be non-zero even if the semi-strong form of the Pecking Order Model is valid.

0.86. The parameter estimates and the impressive ability of the Pecking Order Model to explain debt issues, as well as the relatively favorable power properties discussed below, led Shyam-Sunder and Myers to prefer the Pecking Order Model.

These empirical results can be interpreted in terms of a simple graph. Fig. 1 plots  $\Delta D$  and DEF on the vertical and horizontal axes, respectively, and, without loss in generality, these variables range from zero to unity. Assume that there are 100 time periods and, consistent with aggregate data, 89% of external financing needs are met by new debt with the remaining deficit covered by new equity.<sup>2</sup> This mix of debt and equity implies that, for 67% of the observations, the deficit-in-funds is met only by debt issues.<sup>3</sup> During the remaining periods, the deficit is covered by a mix of debt (the distance from the horizontal axis to the horizontal solid line) and equity (the distance from the horizontal solid line to a 45° line emanating from the origin). The least squares estimate of  $b_{PO}$  from this model is 0.74.<sup>4</sup> Thus, the data graphed in Fig. 1 reproduce Shyam-Sunder and Myers' empirical results, which are consistent with the semi-strong form of the Pecking Order Model recognizing equity finance at the bottom of the financing hierarchy.

Before evaluating the ability of Eq. (1) to discriminate among competing hypotheses, we mention another important aspect of the Shyam-Sunder and Myers paper, its emphasis on assessing empirically the power of regression tests. The authors introduce a method to evaluate alternative models: debt financing histories are simulated using a specific model of capital structure and data inputs for actual firms, and then an alternative model is evaluated econometrically using this simulated series. They demonstrate that the Static Tradeoff

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<sup>2</sup> The data are from a special compendium of the SIA Fact Book (Securities Industry Association, 1990), and refer to U.S. corporate underwriting activity from 1980 to 1989 for both public and private placements. Issues of high-yield bonds are subtracted from total debt, and issues of preferred stock and initial public offerings are subtracted from equity. The reported ratio is average debt issues (adjusted) divided by the sum of this number and average equity issues (adjusted), where the averages are computed for 1980–1989.

<sup>3</sup> The critical value of 0.67 equates the area under the solid curve (representing new debt finance) to 89%, and defines the “kink” in the solid line. Algebraically,  $X$  (the critical value) is the solution to the following quadratic equation:

$$[X^2/2.0 + X*(1 - X)]*2.0 = 0.89,$$

where the left-side is multiplied by 2.0 to normalize the deficit-in-funds (the area under the 45 degree line ranging from 0.0 to 1.0) to unity. One of the two solutions to this quadratic equation is greater than one, hence inadmissible.

<sup>4</sup> The least squares estimate is based on  $\Delta D$  and DEF being distributed uniformly from 0.0 to 1.0 (in increments of 0.01) according to the true model represented by the solid line in Fig. 1. The results are independent of the size of the increments.

Model has low power against the Pecking Order alternative when data are generated by the Pecking Order Model. However, the reverse is not true, as the Pecking Order Model correctly rejects when data are generated by the Static Tradeoff Model. This technique is further applied to cross-section tests [see Shyam-Sunder and Myers (1999), Section 4.4]. The Static Tradeoff Model is represented by a regression of debt on R&D, plant, earnings, and tax loss carry forwards (all relative to assets). When the debt ratio is generated by the Pecking Order Model, cross-section regressions using the above variables fail to reject, indicating that the Static Tradeoff Model lacks power in this frequently used regression.

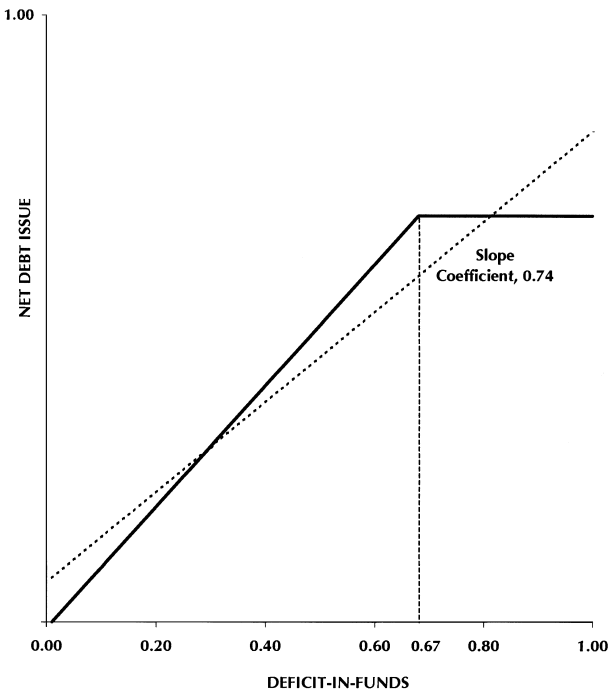


Fig. 1. The solid line represents the true model in which 89% of the deficit-in-funds (DEF) is met by net debt issue ( $\Delta D$ ) with the remaining deficit covered by net equity issue. This mix of debt and equity implies that, for 67% of the observations, DEF is met only by debt issues. During the remaining periods, DEF is covered by a mix of debt (the distance from the horizontal axis to the horizontal solid line) and equity (the distance from the horizontal solid line to a 45° line emanating from the origin). See fns. 2 and 3 for further details about the construction of the figures. The dashed line represents the fitted value from the least squares regression of  $\Delta D$  on DEF with an estimated slope coefficient,  $b_{PO} = 0.74$ . The least squares estimate is based on  $\Delta D$  and DEF being distributed uniformly from 0.0 to 1.0 (in units of 0.01) according to the true model.

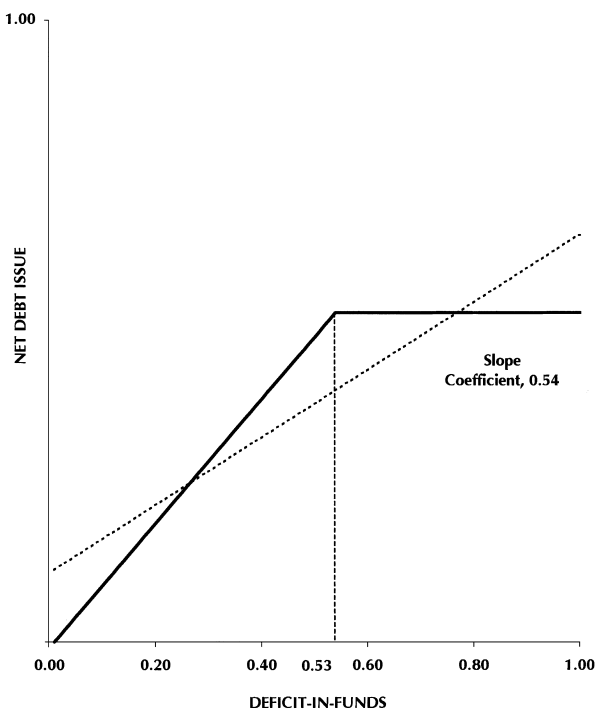


Fig. 2. The solid line represents the true model in which 78% of the deficit-in-funds (DEF) is met by net debt issue ( $\Delta D$ ) with the remaining deficit covered by net equity issue. This mix of debt and equity implies that, for 53% of the observations, DEF is met only by debt issues. During the remaining periods, DEF is covered by a mix of debt (the distance from the horizontal axis to the horizontal solid line) and equity (the distance from the horizontal solid line to a 45° line emanating from the origin). See fns. 2 and 3 for further details about the construction of the figures. The dashed line represents the fitted value from the least squares regression of  $\Delta D$  on DEF with an estimated slope coefficient,  $b_{PO} = 0.54$ . The least squares estimate is based on  $\Delta D$  and DEF being distributed uniformly from 0.0 to 1.0 (in units of 0.01) according to the true model.

### 3. Inference problems

Consideration of three plausible alternative patterns of external financing raises serious questions about the validity of inferences based on Eq. (1). Assume that the firm follows the financial hierarchy consistent with the Pecking Order Model, relying initially on debt finance and then equity finance. However, unlike the analysis in Section 2 and Fig. 1, assume that equity issues constitute a more substantial percentage of overall external finance. Such a situation might arise because debt finance becomes relatively costly as a result of changes in business

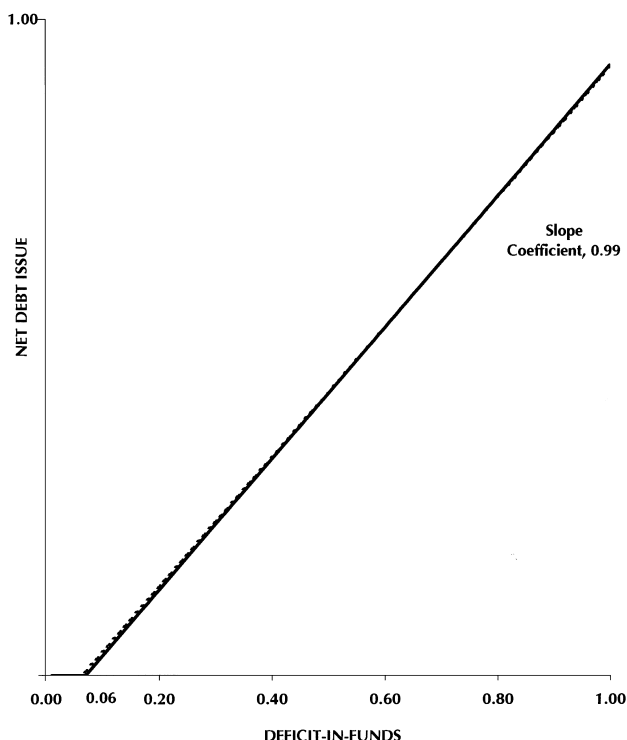


Fig. 3. The solid line represents the true model in which 89% of the deficit-in-funds (DEF) is met by net debt issue ( $\Delta D$ ) with the remaining deficit covered by net equity issue. This mix of debt and equity implies that, for 6% of the observations, DEF is met only by equity issues. During the remaining periods, DEF is covered by a mix of equity (the distance from the sloping solid line to a 45° line emanating from the origin) and debt (the distance from the horizontal axis to the horizontal solid line). See fns. 2 and 3 for further details about the construction of the figures. The dashed line represents the fitted value from the least squares regression of  $\Delta D$  on DEF with an estimated slope coefficient,  $b_{PO} = 0.99$ . The least squares estimate is based on  $\Delta D$  and DEF being distributed uniformly from 0.0 to 1.0 (in units of 0.01) according to the true model.

conditions, information asymmetries, or tax rules.<sup>5</sup> As shown in Fig. 2, a doubling of the proportion of equity finance from 11% to 22% markedly lowers  $b_{PO}$  from 0.74 to 0.54.<sup>6</sup> Thus, even though the Pecking Order Model is valid, the testing strategy proposed by Shyam-Sunder and Myers suggests rejection. Tests of the

<sup>5</sup> Shyam-Sunder and Myers (1999, Section 2.2) note that their testing strategy may not be applicable at high leverage ratios when debt capacity is exhausted. However, the criticism raised in this section is that, when the proportion of equity finance is large for whatever reason, Eq. (1) will not be useful for testing the Pecking Order Model.

<sup>6</sup> When equity issues constitute 33% or 44% of external finance,  $b_{PO}$  falls to 0.40 or 0.27, respectively.

Pecking Order Model based on Eq. (1) are tests of the joint hypothesis of ordering (the financial hierarchy) and proportions (equity issues constitute a low percentage of external financing).

Even if one maintains a favorable assumption about the proportion of equity finance, tests based on Eq. (1) are unable to detect situations where the ordering hypothesis is violated. The key empirical prediction of the Pecking Order Model is that equity issues, if they occur at all, are at the bottom of the financial hierarchy. Unfortunately, the ability of Eq. (1) to identify this financing pattern against relevant alternatives is limited. Consider a situation in which equity issues are in the middle of the financial hierarchy; for example, firms rely initially on internal funds, but then issue equity before issuing debt. Such a situation might occur if there are hidden costs to debt or hidden benefits to equity that have not yet been identified by researchers. This convoluted financial hierarchy is depicted in Fig. 3, where we again assume that 11% of DEF is met by equity issues. This financing pattern is strongly at odds with the Pecking Order Model, and should be rejected by the test based on Eq. (1). However, the least squares estimate of  $b_{PO}$  is 0.99, a result suggesting incorrectly that the Pecking Order Model is valid.

Lastly, consider a third case in which debt and equity are always issued in fixed proportions, as might arise if there exists an optimal debt/equity ratio. In this case, each dollar of DEF is financed by \$0.89 of debt, and this financing pattern is represented by a straight-line emanating from the origin with a slope of 0.89. Estimating Eq. (1) on this series of debt issues would result in  $b_{PO} = 0.89$  and an  $R^2 = 1.0$ , thus leading to the incorrect inference that this financing pattern is consistent with the Pecking Order Model.

In sum, these three situations highlight serious difficulties with using Eq. (1) to evaluate the Pecking Order Model. Our results, coupled with the power problem with the Static Tradeoff Model documented by Shyam-Sunder and Myers, indicate that their empirical evidence can evaluate neither the Pecking Order nor Static Tradeoff Models. Alternative tests are needed that can identify the determinants of capital structure and can discriminate among competing hypotheses.

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