Do Firms Rebalance Their Capital Structures?

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Abstract

We empirically examine the trade-off theory of capital structure, allowing for costly adjustment. After confirming that financing behavior is consistent with the presence of adjustment costs, we use a dynamic duration model to show that firms behave as though adhering to a dynamic trade-off policy in which they actively rebalance their leverage to stay within an optimal range. We find that firms respond to changes in their equity value, due to price shocks or equity issuances, by adjusting their leverage over the two to four years following the change. The presence of adjustment costs, however, often prevents this response from occurring immediately, resulting in shocks to leverage that have a persistent effect. Our evidence suggests that this persistence is more likely a result of optimizing behavior in the presence of adjustment costs, as opposed to market timing or indifference.

The trade-off theory of capital structure posits that firms have an optimal or target debt-to-equity ratio that perfectly balances the costs and benefits of debt financing. The costs of debt financing include the potential for costly bankruptcy and agency conflicts. The benefits include the tax deductability of interest payments and the mitigation of free cash flow problems. While originally conceived as a static theory, a natural implication of the trade-off theory is the dynamic rebalancing of capital structure. Over time, both the target and actual leverage of firms may change as a result of changes in firm characteristics or market perturbations to the value of debt and equity. If this change results in a firm's actual capital structure deviating from the target, the trade-off theory predicts that the firm will adjust its capital structure in order to equate its actual leverage with the optimal leverage.

One problematic aspect of the trade-off theory and many corresponding empirical tests is the assumption of costless adjustment. In the absence of adjustment costs, the trade-off theory predicts that firms continuously adjust their capital structures to maintain the value-maximizing leverage ratio. However, in the presence of such costs, firms may not find it optimal to respond immediately to shocks that push them away from their target. If the costs of such adjustments outweigh the benefits, firms will wait to recapitalize, resulting in "extended excursions away from their targets" (Myers (1984)). Recognizing these costs, firms do not simply have an optimal level of leverage but an optimal range in which they are inactive with respect to their financial policy. Indeed, Fischer et al. (1989) show that even a small cost of recapitalization can result in long periods of inactivity. The consequence of this view is that leverage will be persistent, in the sense that firms will not always respond to shocks that perturb their capital structure. Thus, observed leverage may be a noisy measure of corporate financial policy, suggesting that one must look elsewhere to uncover the motivation behind corporate capital structure.

The goal of this paper is to test the trade-off theory, while allowing for costly adjustment. Specifically, we examine corporate financing decisions in a dynamic duration model and address three questions. First, is financing behavior consistent with the existing empirical evidence concerning adjustment costs (see, for example, Smith (1986), Lee et al. (1996), and Altinkilic and Hansen (2000))? Altinkilic and Hansen (2000) estimate equity and debt issuance cost functions that have several implications for the temporal variation in issuance decisions. Additionally, most equity repurchases are governed by SEC rule 10b-18, which restricts the size and frequency of such transactions (see Cook et al. (2003)).

Second, do firms make financing decisions that are consistent with a dynamic rebalancing of leverage, as implied by a trade-off theory? In other words, we ask why firms make leverage adjustments when they do, as opposed to why firms have different leverage ratios. In doing so, we are able to test a number of predictions concerning the dynamic behavior of financial policy in the presence of adjustment costs, as generated by models such as Fischer et al. (1989).[1]

Finally, what are the implications of costly adjustment for alternative explanations of financing behavior based on recent empirical evidence? Studies by Baker and Wurgler (2002) and Welch (2004) argue, contrary to the trade-off theory, that firms do not rebalance their capital structure in response to equity issuances and shocks to equity values. Studies by Shyam-Sunder and Myers (1999) and Lemmon and Zender (2002) find that firms' financial policies are best described by the pecking-order theory (Myers (1984) and Myers and Majluf (1984)).

We begin by showing that firms are inactive with respect to their financial policy a majority of the time, but when they do issue or repurchase debt and equity, they do so in clusters. In almost 75% of our sample's firm-quarter observations, firms neither issue nor repurchase their own securities. However, firms are still quite active, issuing or repurchasing securities on average once a year. Further, when firms do decide to visit the capital markets they tend to do so in several closely spaced, often consecutive, quarters. This temporal pattern in financing decisions is generally consistent with the recent empirical evidence of Altinkilic and Hansen (2000), who show that debt and equity issuance costs consist of both a fixed cost and a convex variable cost. It is also consistent with the provisions of SEC rule 10b-18, which restricts the timing and amount of share repurchases on any given day.

We then examine the motivations behind corporate financing decisions, which we find to be consistent with trade-off behavior. More specifically, we find that firms are significantly more likely to increase (decrease) leverage if their leverage is relatively low (high), if their leverage has been decreasing (accumulating), or if they have recently decreased (increased) their leverage. This dynamic rebalancing suggests that firms behave in a manner consistent with the trade-off theory, as predicted by the model of Fischer et al. (1989). If leverage lies within a target range, firms are inactive with respect to their capital structure. Only when leverage moves outside the target range do firms make rebalancing adjustments. This result is also consistent with the survey evidence of Graham and Harvey (2001), which shows that managers are concerned with the costs and benefits of debt financing (credit ratings, cash flow volatility and tax shields are

[1] See other studies Ju (2001), Ju et al. (2002) and Hennessy and Whited (2003), for example.

"important" or "very important" to almost half of those CFOs surveyed). Finally, our rebalancing result is consistent with previous empirical work that finds mean reversion in leverage (Jalilvand and Harris (1984), Roberts (2001) and Roper (2002)). It also explains why the rate at which leverage reverts to its target is often characterized as slow;[2] firms do not rebalance every period and when they do, it is to a target range, rather than a specific level. Hence, shocks to leverage have lasting effects despite trade-off behavior.

Our results call into question not the findings, but the conclusions of Baker and Wurgler (2002) and Welch (2004), who argue that because leverage appears unresponsive to various shocks, the trade-off theory is an inappropriate description of corporate financial policy. When we look more closely at their results, we find that the persistent behavior of leverage revealed by their empirical tests is more likely due to adjustment costs, as opposed to market timing or indifference. Specifically, we find that the effect of Baker and Wurgler's key market timing variable on leverage attenuates in a significant manner as adjustment costs decline, illustrating that adjustment costs appear to dictate the speed at which firms respond to shocks to leverage. Further, our nonparametric and duration analyses shows that the effect of equity issuances on firms' leverage is erased within two years by debt issuances. We also find that after simulating data from the dynamic trade-off model of Fischer et al. (1989), we obtain very similar empirical results as those in Welch (2004). Additionally, our analysis shows that firms respond to large positive (negative) equity shocks by rebalancing their capital structure through debt issuances (retirements), thereby erasing any impact on leverage within a few years.

Though we do not explicitly test the pecking order theory of Myers and Majluf (1984) and Myers (1984), several of our results are consistent with its predictions. More profitable firms and firms with greater cash balances are less likely to use external financing, while firms with large anticipated investment expenses are more likely to use external financing. Taken in conjunction with the recent evidence supporting the "modified" pecking order (see Shyam-Sunder (1999) and Lemmon and Zender (2002)), our rebalancing results suggest that both the bankruptcy costs associated with debt financing and the information asymmetry costs associated with equity financing are important determinants of capital structure decisions. However, more research focused specifically on the predictions of the pecking order, as in Lemmon and Zender (2002), for example, is needed in order to distinguish between the pecking order and traditional trade-off theories.

The remainder of the paper proceeds as follows. Section I discusses the trade-off theory in the presence of adjustment costs and its empirical implications. Section II

[2]See, for example, Fama and French (2002).

discusses the data and sample selection procedure, in addition to presenting summary statistics. Section III motivates the empirical approach. Section IV presents the estimation results. Section V discusses alternative theories of capital structure and reconciles our findings with previous evidence. Section VI concludes.

I. The Dynamic Trade-off Theory

A. Leverage Dynamics

A.1. The Impact of Adjustment Costs

The trade-off theory has a number of empirical implications that depend on which costs and benefits one associates with debt financing. Rather than focusing on the perceived costs and benefits, as done in most previous empirical work, we focus on the implications for the dynamics of leverage adjustments, while controlling for any perceived costs and benefits. Our empirical measure of leverage is the ratio of the book value of total debt to the sum of total debt and the market value of equity.[3]

The trade-off theory implies that firms actively rebalance their capital structures by increasing or decreasing their leverage in response to shocks that move them away from their optimal leverage. Most empirical treatments have implicitly assumed that this rebalancing is to a unique target level and that it takes place continuously through time (i.e. every period).[4] This assumption is the motivation behind the partial adjustment model found in many studies.[5] However, in the presence of a fixed or proportional adjustment cost, continuous adjustment may no longer be optimal and the impact on capital structure dynamics can be profound.

The effect of different adjustment costs on the dynamic behavior of optimizing agents has been show in many contexts including: inventory management (Harrison (1985)), cash management (Miller and Orr (1966)), investment policy (Caballero and Engle (1999), portfolio selection (Constantinides (1986)), and capital structure (Fischer et al.

[3]We repeat all of our analyses using book leverage, defined as the ratio of total debt to the book value of total assets. Our results and conclusions are unaffected.

[4]The absence of adjustment costs or a strictly convex adjustment cost function will generate such behavior.

[5]See studies by Jalilvand and Harris (1984), Roberts (2001), Roper (2002) for explicit partial adjustment models. However, since the partial adjustment model is simply a reparameterization of a first order autoregression, the models of Graham (1996) and others may also be interpreted as assuming a continuous adjustment process.

(1989)). The most apparent effect of adjustment costs is often periods of inactivity, as agents wait for the benefits of adjustment to become sufficient to offset the costs. In the context of the Fischer et al. (1989) model of capital structure, firms wait to adjust their leverage until the costs of debt recapitalization are offset by the benefits, either an increased tax advantage or decreased expected bankruptcy cost depending on whether the firm decides to increase or decrease leverage. The size and frequency of the recapitalization depends, in large part, upon the structure of the adjustment cost function.

Figure 1 presents leverage ratios simulated under three different adjustment cost scenarios: a fixed cost (Panel A), a proportional cost (Panel B), and a fixed cost plus a weakly convex cost component (Panel C). The simulations are implemented assuming that leverage follows a random walk in the no-recapitalization region, defined by the lower ($\underline{\mathrm{L}}$) and upper ($\bar{\mathrm{L}}$) boundaries. Typically, the boundaries and initial leverage are derived as the solution to a dynamic programming problem and are complex functions of the underlying parameters of the model (see, for example, Fischer et al. (1989)). Since our goal, at this point, is only to illustrate the intuition behind the impact of adjustment costs on leverage, we choose boundaries that are one standard deviation from the initial leverage value and implement the optimal recapitalization policy corresponding to each cost scenario. The optimal policy under different cost scenarios is discussed in a number of earlier works spanning several fields, including operations research (Harrison (1985)), economics (Caplin (1985)) and finance (Constantinides (1986)). While the optimality of such policies depends upon the theoretical environment, the intuition of the recapitalization policy and corresponding leverage dynamics are dictated primarily by the functional form of the adjustment costs. Indeed, the random shocks driving each simulation in Figure 1 are identical. Differences in the simulated paths are solely the result of different recapitalization policies induced by the different cost structures.

Under a fixed cost regime, as in Fischer et al. (1989), the optimal control policy is to make one large adjustment upon reaching a boundary, thereby returning leverage to its initial level (L^*). The intuition for such a policy is that once the benefits from adjustment outweigh the cost, the firm can make as large an adjustment as it desires because the cost and size of the adjustment are independent of one another. The outcome of this policy is illustrated in Panel A. Each time leverage touches a boundary ($\underline{\mathrm{L}}$ or $\bar{\mathrm{L}}$), the firm issues/repurchases debt so as to return leverage to its initial value (L^*). Points of recapitalization are denoted by the circles on the dotted line.[6] The resulting leverage

[6]More precisely, in the Fisher et al. (1989) model, firms costlessly repurchase all outstanding debt and issue a new amount that is either more or less than the previous amount, depending on whether

behavior is best described as "lumpy", as firms irregularly make one relatively large adjustment. Thus, the defining characteristics of a fixed cost and the corresponding recapitalization policy is that leverage adjustments are large and occur infrequently.

Panel B presents the results of the optimal control policy under a proportional cost function.[7] The recapitalization policy in this scenario mandates that firms make very small, continuous changes upon reaching a recapitalization boundary. Cost minimizing firms recognize that each additional dollar of adjustment incurs an additional cost, so that the minimum adjustment to return leverage to the optimal range will take place. Thus, leverage adjustments tend to be very small and highly clustered in time.

Panel C presents the results for a cost function consisting of both fixed and weakly convex components. The optimal control policy in this case lies between that of the strictly fixed cost and strictly proportional cost cases. When leverage reaches a boundary, the size of the adjustment is such that leverage returns somewhere between the fixed cost optimum and the closest boundary. For example, when leverage hits the upper boundary $\bar{\text{L}}$ firms adjust so that leverage returns to $\bar{\text{L}}^*$. The fixed cost induces firms to make a large enough adjustment so that the benefit of adjusting overcomes the fixed component of the cost function. However, the convex cost penalizes each additional dollar. Thus, the size and frequency of leverage adjustments fall somewhere in between the two extremes illustrated in Panels A and B.

Guided by previous research, we use three different proxies for the direct costs of security issuance. First, we use the underwriter spread estimates from Altinkilic and Hansen (2000) to proxy for the issuance costs of debt and equity. Altinkilic and Hansen regress underwriter spreads on the size of the issuance and the size of the issuance relative to the size of the firm (i.e. market capitalization). We use their estimated parameters to estimate underwriter spreads for our sample of firms. We also use credit ratings as a proxy for debt issuance costs, as suggested by Lee et al. (1996). In a similar spirit, we use Altman's Z-Score (1968) as an additional proxy for debt issuance, though we note that Z-Score (and credit ratings) may also capture expected costs of financial distress.[8]

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the lower or upper boundary is struck. The adjustment cost is proportional to the par value of the new debt issue. Since the size of the new issue always returns the firm to the same leverage ratio, the cost is effectively fixed. Fischer et al. also allow for the possibility of bankruptcy, in which case the lower boundary becomes an absorbing barrier.

[7]In the Fischer et al. (1989) setting, the cost is proportional to the *change* in face value of debt. Constantinides (1986) implements such a control policy under proportional costs in the context of portfolio selection.

[8]We modify Altman's Z-Score to be defined as the reciprocal of: assets divided by the sum of 3.3

A recent study by Cook et al. (2003) shows that most equity repurchase programs adhere to the provisions of SEC Rule 10b-18, which provides a safe harbor for firms against charges of stock price manipulation based solely on the timing or price of repurchases. The Rule imposes restrictions on the timing, price and amount of shares that firms may repurchase on any given day. Most relevant for our discussion is that nonblock purchases for a day cannot exceed the greater of one round lot and the number of round lots closest to 25% of the security's trading volume. In so far as this restriction is binding, it may be viewed as imposing a significant variable cost since shares purchased in excess of the prescribed limit are in violation of an SEC rule and thus subject to legal action. As such, we use the maximum turnover during the period as a measure of the restrictiveness of the volume provision. Greater turnover implies greater freedom in repurchasing shares and thus lower costs.

Unfortunately, we have little help from past research regarding the cost of debt retirement. This is not to say that early retirement of debt is free of any direct costs. In the case of privately placed debt, early retirement can often incur penalties, renegotiation costs, and other fees.[9] Publicly placed debt retirement faces a different difficulty in the form of illiquid secondary markets (see, for example, the discussion in Chen et al. (2003)). While we have no specific proxies for the direct costs of retiring debt, our hope at this point is that our analysis can lend some insight into the form of any costs firms may face in retiring debt. An explicit examination of this issue, however, is beyond the scope of this study.

A.2. Dynamic Trade-off Predictions

Returning to Figure 1, we note several important issues that are relevant for the empirical analysis of capital structure. First, the persistence of shocks on the leverage process is insufficient to reject a dynamic trade-off theory. Under each cost regime discussed above, shocks to leverage do not induce a response as long as the leverage process remains in the no-recapitalization region (i.e. between $\underline{L}$ and $\bar{L}$). Further, the size of the response need not completely offset the shock, returning leverage to its pre-shock level. Second, the structure of adjustment costs dictates the size and frequency of adjustments. As adjustment costs transition from fixed (Panel A), to fixed plus convex (Panel C), to

times earnings before interest and taxes plus sales plus 1.4 times retained earnings plus 1.2 times working capital. A similar measure is employed in Mackie-Mason (1990) and Graham (1996).

[9]We thank Steven Roberts of Toronto Dominion and Rob Ragsdale of First Union for their insight on commercial lending.

proportional (Panel B), we see the size of adjustment decrease and the frequency of adjustment increase. Finally, examination of the temporal or cross-sectional variation in the level of (or change in) leverage can be misleading when it comes to inferring financing behavior. Two otherwise identical firms, both following a dynamic trade-off strategy, can have very different leverage ratios and leverage dynamics simply due to different random shocks to their capital structures. In order to understand the motives behind corporate financial policy, we focus on the determination of the adjustments themselves (i.e. why firms adjust when they do?).

Using the dynamic trade-off framework illustrated in Figure 1 as a motivation for the empirical analysis results in three clear predictions concerning leverage adjustments. The underlying theme of these predictions is that any force that moves the leverage process closer to a particular recapitalization boundary, increases the likelihood of hitting that boundary and therefore increases the probability of making a particular adjustment (leverage increase or decrease). Thus, the higher the level of leverage, all else equal, the more likely that leverage will hit the upper boundary and the firm will decrease its leverage. The lower the level of leverage, the more likely that leverage will hit the lower boundary and the firm will increase its leverage. Simply put, we expect a negative association between the level of leverage and the direction of adjustment (leverage increase or decrease).

Similarly, an accumulation (decrease) in leverage should result in a greater likelihood of decreasing (increasing) leverage. Thus, we also expect a negative association between the change in leverage and the direction of adjustment.

Finally, past leverage adjustments will also affect the likelihood of adjustment. For example, after reaching a lower boundary a firm increases its leverage moving it closer to the upper boundary. Thus, the likelihood of subsequently decreasing its leverage goes up since it is now closer to the upper boundary, even though leverage may still be *relatively* closer to the lower boundary, as in the case of proportional or, fixed plus convex adjustment costs. So while leverage may still be more likely to hit the lower boundary again before hitting the upper boundary, the key point is that the adjustment moved leverage closer to the upper boundary making the process more likely to reach that boundary than it was prior to the adjustment.

B. The Costs and Benefits of Debt

Though our focus is on the dynamic implications of the trade-off theory, we must also account for the perceived costs and benefits of financial policy. The original static trade-off theory views the costs of debt as corresponding to bankruptcy costs, both direct (e.g., legal fees and administrative costs) and indirect (e.g., customer flight and reputation loss). We examine the volatility of cash flows, measured by the absolute value of the change in net income normalized by book assets, as a proxy for the likelihood of becoming financially distressed. We examine the ratio of selling expenses to total sales as a measure of product uniqueness (see Titman and Wessels (1988) and Korajczyk and Levy (2003)). Companies with firm-specific assets may experience greater financial distress costs due to the greater difficulty associated with liquidating these assets in the market. Finally, asset tangibility, measured by the fraction of total assets attributable to property, plant and equipment (Rajan and Zingales (1995)), is used to proxy for bankruptcy recovery rates. Those firms with a greater fraction of tangible assets may have a higher recovery rate in bankruptcy and correspondingly lower costs. This measure also proxies for the firm's ability to collateralize debt. The benefits of debt are associated with the tax shield it provides. We use depreciation and amortization as a fraction of total assets (DeAngelo and Masulis (1980) and Titman and Wessels (1988)) to measure non-debt tax shields that offset the tax benefits of debt financing.

Agency-based models associate the costs of debt with asset substitution (Jensen and Meckling (1976)) and underinvestment (Myers (1977)). Thus, firms with large growth or investment opportunities, as measured by capital expenditures relative to total assets (Titman and Wessels (1988)) and the market-to-book ratio (which we define as total assets minus book equity plus market equity, all divided by total assets), should be less likely to use debt financing.[10] The benefits of debt in an agency cost framework come from its ability to constrain managerial discretion and mitigate the free cash flow problem (Jensen and Meckling (1976) and Zwiebel (1996)). More profitable firms, measured by after tax operating income divided by total assets, are thus more likely to use debt financing.

For completeness, we incorporate several other variables that have been used in previous studies. Firm size is measured by firm sales in period t divided by the total sales of

[10]We also note that the market-to-book ratio may capture the effect of stock prices on firm's financing decisions. Indeed, Baker and Wurgler (2002) use a weighted average of historical market-to-book ratios as the basis for their market timing hypothesis. In an effort to better isolate the effect of stock price movements on corporate decisions, we also examine the effect of the previous year's equity return.

our sample during period t. The normalization is used to correct for the nonstationarity of the sales variable. Titman and Wessels (1988) argue that larger firms may be more diversified and, as such, less likely to enter financial distress. Thus, larger firms are more likely to use debt financing. To capture any macroeconomic effects (Korajczyk and Levy (2003)) we incorporate year and quarter dummies into the analysis. Similarly, 2-digit SIC code dummies are included to capture any industry-specific variation in financing choices (MacKay and Phillips (2003)). Finally, we include the level of cash as a fraction of book assets to control for a firm's ability to finance investment with internal funds. In sum, our control variables represent a fairly comprehensive set of those variables used in previous studies.

II. Data, Sample Selection and Summary Statistics

The data are taken from the combined quarterly research, full coverage and industrial COMPUSTAT files for the years 1984 - 2001.[11] We also extract return data from the CRSP monthly stock price file. All regulated (SICs 4900-4999) and financial firms (SICs 6000-6999) are removed from the sample to avoid financial policy governed by regulatory requirements and maintain consistency with earlier studies (e.g. Fama and French (2002), Frank and Goyal (2003) and Korajczyk and Levy (2003)). Any observations with missing data for the book value of assets, stock issuances, stock repurchases, short term debt or long-term debt are deleted because these variables are required to determine whether an issuance or repurchase has occurred. Finally, since the emphasis of this study is on dynamic capital structure, we restrict our attention to firms with at least four years of contiguous observations.[12] The final dataset is an unbalanced panel containing 127,308 firm-quarter observations: 3,494 firms each with a time series of observations ranging in length from 16 to 71 quarters.[13]

A. Capital Structure Adjustments

To define when a change in capital structure has occurred, we follow the approach used by Hovakimian et al. (2001), Hovakimian (2003) and Korajczyk and Levy (2003). An issuance or repurchase is defined as having occurred in a given quarter if the net change in

[11]This start date was chosen since our key equity issuance and repurchase variables are not available at a quarterly frequency prior to 1984.

[12]We relax and tighten this restriction to three and five years with no effect on our results.

[13]The maximal time series length is not 72 (18×4) quarters because of the inclusion of lagged data.

equity or debt, normalized by the book value of assets at the end of the previous period, is greater than 5%. For example, a firm is defined as having issued debt in quarter t when the change in the total value of debt from quarter $t-1$ to t, divided by the book value of assets at the end of quarter $t-1$, exceeds 5%. We define four basic types of financing "spikes": equity issuances, equity repurchases, debt issuances, and debt retirements, each of which is represented mathematically by a binary variable indicating whether or not a spike has occurred for firm i in period t. With the exception of equity repurchases, all spike definitions use the 5% cutoff. Equity repurchases use a 1.25% cutoff to avoid missing the numerous smaller sized repurchase programs in place.[14]

While there may be instances of misclassification using this scheme, such as when convertible debt is called or when an equity account is transferred from a subsidiary to a parent, Hovakimian et al. (2001) show that analysis carried out using new debt and equity issue data from SDC produces similar results to analysis using the 5% classification scheme. Korajczyk and Levy (2003) also confirm the accuracy of this classification scheme. We present additional accuracy checks below and note that Whited (2003) uses a similar approach to identify investment decisions. This classification also allows us to capture changes in total debt due to private debt net issuing activity that may not be tracked by the SDC database. As Houston and James (1996) and Bradley and Roberts (2003) show, the majority of corporate debt is comprised of private placements. [15]

In addition to the four basic types of financing spikes, we examine two additional measures of capital structure adjustment that we refer to as leverage increasing decisions and leverage decreasing decisions (or, more succinctly, as leverage increase and leverage decrease). Since our focus is on corporate decisions that impact leverage, we require measures that can isolate the effect of financial decisions on leverage, while ignoring those financing decisions that have no impact. For example, a firm that issues debt and equity in proportions equal to the firm's previous debt-equity ratio does not affect its leverage, despite the fact that it has undertaken a large amount of net issuing activity. To isolate those decisions that impact leverage, we define a leverage increase as net debt issuance minus net equity issuance, divided by book assets, in excess of 5%, and a leverage decrease as net equity issuance minus net debt issuance, divided by book assets, in excess

[14]We thank Roni Michaely and Ray Groth for bringing our attention to this issue.

[15]As a robustness check, we also perform the analysis using a 3% and 7% cutoff for debt issuances, debt retirements and equity issuances with negligible effect on our results. We also vary the equity repurchase cutoff from 0.5% to 3%, again with negligible effect on our results. As such, we present results based only on the 5% (1.25% for equity repurchases) cutoff, in what follows.

of 5%.[16] As with the four financing spikes, the mathematical representation of each of these leverage adjustments is a binary variable.

Table I presents summary statistics for each type of adjustment. Perhaps the most striking result is that in 72% of the quarters in our sample no adjustment occurs. That is, a majority of the time firms are inactive with respect to their capital structure. However, since we are employing quarterly data, a 72% inactivity rate implies that the average firm adjusts their capital structure approximately once a year. Thus, financing activity is actually quite frequent, but far from continuous. This inactivity is consistent with the presence of adjustment costs, but could also be consistent with the alternative hypothesis that firms are indifferent toward leverage, as market timing or inertia would predict. A more thorough examination of these alternatives is postponed until the formal modelling below.

The most common form of adjustment is debt issuances, which account for over 40% of all capital structure adjustments.[17] This is followed by debt retirements (28%), stock issuances (17%) and stock repurchases (14%). On a per firm basis, we see a similar pattern. The average firm has approximately 36 quarters worth of data and experiences 4.2 debt issuances, 2.8 debt retirements, 1.9 equity issuances, and 2.8 equity repurchases. We also note that there are a significant number (2,219) of joint stock issuance and debt retirement observations, which are captured by the leverage decrease measure but not explicitly reported in the table.

Table I also presents summary information on financing spell durations, which is the amount of time between financing spikes. Financing spells and their duration are analogous to unemployment spells and the amount of time unemployed. The median duration of each type of spell ranges from 3 quarters for debt issuances to 5 quarters for equity issuances. However, we refrain from drawing any conclusions from these durations, as they represent unconditional estimates from a heterogeneous sample containing censored durations and are likely quite biased. Because the sample ends in 2001 and some firms drop out of the sample prior to 2001 (e.g., bankruptcy), there are a number of right-censored spells. Right-censoring occurs when a spell is still ongoing at the end of a firm's data series. For example, a firm that issues debt in the first quarter of 2000 and then

[16] As with the four basic adjustments, we also examine the effect of using a 3% and 7% cutoff on our results. This change has little effect on our results.

[17] We note that these issuances are not rollovers of debt, except in the unlikely situation that there is a delay between retirement and issuance that forces the recording of each event to occur in separate quarters.

does not issue debt again before the end of the sample period, has a right censored debt issuance spell with a duration of seven quarters. For right-censored spells we can only place a lower bound on the duration of the spell. The consequence of right censoring is a downward bias in the unconditional duration estimates, which we address in the formal modelling. Because the first spell is measured with respect to the first observed financing spike, there is no left-censoring, as well as no IPOs.[18]

The bottom two rows of Table I present summary information concerning leverage adjustments. Firms tend to increase their leverage more often than they decrease it (12.9% compared to 11.9%). If a firm, on average, experiences positive drift in its equity value then leverage has a natural tendency to decline. To counteract this tendency, the trade-off theory implies that firms will lever up more often than down. Thus, this preliminary evidence suggests that firms counteract the natural tendency of equity values to rise over time.

Table II presents summary statistics on the magnitude of the different types of adjustments. All dollar values are inflation adjusted to 2001 dollars using the All-Urban CPI. We focus our discussion of these results on medians because of the large skew in each measure's distribution. Debt issuances and retirements are comparable in magnitude, with median sizes of $7.8 million and $6.6 million, respectively. Median equity issuances are quite small ($3.6 million), while equity repurchases represent the largest adjustment ($11.2 million).

We make two comments concerning these amounts. First, though equity issuances (repurchases) represents the smallest (largest) adjustment in terms of dollar magnitude, they represents the largest (smallest) adjustment in terms of magnitude relative to total assets. Thus, small firms issue equity, while large firms repurchase equity, a finding consistent with that of Frank and Goyal (2003) and Lemmon and Zender (2002). Second, because of the large number of small firms in our sample, the average and median issuance and retirement figures appear quite small. However, when we look at the subsample of our firms that meet the sample selection criteria of Altinkilic and Hansen (2000), the average and median size of equity issuances, for example, are comparable.[19] A similar

[18]We also perform all of our analysis on a subsample of firms that have IPO dates in either Security Data Corporations's (SDC) Global New Issue Database or Jay Ritter's IPO database (we thank Andrew Roper for providing this data). The IPO date enables us to establish a time origin for each firm, albeit a public one, independent of the occurrence of the first spell. The results are unchanged from those presented.

[19]More specifically, when we restrict attention to equity issues between $10 and $1,000 million during

comparison of debt issuances with Altinkilic and Hansen's sample is less enlightening since our measures capture private debt issuances, which form the majority of debt financing.

Preliminary evidence of market timing can be seen by comparing the size of equity issuances normalized by the book value of assets (0.20) versus those normalized by the market value of equity (0.09). The other three adjustments show significantly smaller differences in these two measures, suggesting that firms tend to issue equity when the market value of equity is relatively high. A final look at the median ratios of issue/repurchase size to book assets suggests that most capital structure adjustments represent a significant, yet relatively small fraction of firm value.

III. Duration Analysis

A. The Hazard Function

We begin by briefly outlining the intuition behind our statistical approach. The discussion here is informal and given in the context of capital structure adjustment. For a more thorough treatment of duration analysis, see Lancaster (1990) or Kalbfliesch and Prentice (2002).

Let T be a random variable measuring the duration between capital structure adjustments. The hazard function is defined as

$$h(t) = lim_{m \to 0} \frac{Pr(t \leq T < t + m | T \geq t)}{m} \tag{1}$$

and specifies the instantaneous rate at which a firm adjusts its capital structure conditional on not having done so for time t. Less formally, $h(t)m$ tells us the probability that a firm will adjust its capital structure in the next m units of time, conditional on not having adjusted up to time t. For example, the hazard function for debt issuances at $t = 4$ tells us the probability that a firm will issue debt during the next quarter ($m = 1$), conditional on not having done so during the last four quarters ($t = 4$). Thus, by modelling the time between issuing/repurchasing activities, the hazard function provides a description of the dynamic behavior of financing decisions made by the firm.

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the period 1990-1997 made by nonfinancial, nonregulated industrial firms, our average equity issuance size is $44 million compared to Altinkilic and Hansen's figure of $59 million. However, our subsample of firms has a mean market capitalization of $338 million compared to $429 million for the their sample. Thus, the average firm from our subsample is approximately $3/4^{th}$s the size of their average firm. Consequently, the average issuance size for our subsample is approximately $3/4^{th}$s the size of their average issuance. A similar relation holds for median issuances as well.

The hazard function can offer insight into the structure of adjustment costs faced by firms. Figure 2 presents three estimated hazard functions using the simulated leverage data from panels A through C in Figure 1. More specifically, we simulate 100 leverage paths where each path consists of 100 time series observations. For each simulation, we implement the optimal recapitalization policy as determined by the assumed cost function (fixed, proportional, and fixed plus convex). Using this data, we then estimate the hazard curve for leverage increasing adjustments (i.e. adjustments in response to hitting the lower barrier, $\underline{L}$, in Figure 1). That is, we model the time between leverage increasing adjustments. To clearly convey the effect of different adjustment costs on the hazard function, we parameterize $h(t)$ as a cubic polynomial in t and estimate the parameters using maximum likelihood assuming that durations are independent and exponentially distributed.[20]

Panel A of Figure 2 reveals that under a fixed cost of adjustment, the hazard rate is increasing in time, eventually levelling off after 17 periods and then slightly turning downward. However, given the fact that the number of observations with durations greater than 17 periods is relatively small and decreasing with the duration, the estimates of the far right tail of the hazard curve can be quite imprecise. Regardless, the key characteristic of the hazard curve that we note is that it is upward sloping, suggesting that the longer the firm has gone without adjusting its leverage upward, the more likely it is to do so. Returning to Panel A of Figure 1, it is easy to see this intuition. Immediately after a firm increases its leverage, returning it to L^*, the firm is relatively unlikely to strike the lower boundary very soon. As time progresses and the leverage process wanders, the probability that it hits the lower boundary in the near future increases. Thus, large, infrequent adjustments induced by a strictly fixed cost of adjustment result in an upward sloping hazard curve. [21]

Panel B of Figure 2 reveals that proportional adjustment costs induce a steeply downward sloping hazard curve, suggesting that as time passes since the last adjustment, the likelihood of making another adjustment declines rapidly. In light of Panel B in Figure 1, proportional adjustment costs lead to very small adjustments, so that the leverage process is still very close to the lower boundary, $\underline{L}$. This proximity suggests that the likelihood of striking the same boundary again is very high. In order for leverage to not strike the same boundary again soon after the initial contact, the process must drift away from the boundary making it less likely to strike as time passes. Thus, very small

[20]Estimated hazard curves for leverage decreasing adjustmentes yield similar results.

[21]See Whited (2003) for a discussion of these issues in the context of investment decisions.

adjustments induced by a strictly proportional cost results in a steeply downward sloping hazard curve.

Finally, Panel C of Figure 2 shows that a fixed plus a weakly convex cost of adjustment results in a more moderately downward sloping hazard curve, relative to a strictly proportional cost. Again, the intuition is found by referring back to Panel C of Figure 1 and recognizing that the moderate adjustments made by firms lead to a higher likelihood of striking the same boundary soon after adjusting. But, the probability is significantly less in comparison to that under proportional adjustment costs.

We also mention a few final notes on the relation between the hazard curve and adjustment costs. The general level of the hazard curve reflects the overall frequency of adjustments: the higher the level the more frequently adjustments occur, suggesting lower costs of adjustment, and vice versa. Unfortunately, the hazard curve, in and of itself, does not enable us to identify or disentangle the different adjustment costs facing the firm. It merely provides us with a description of the dynamic behavior of corporate financial policy, which we then use to infer the adjustment cost structure firms face, as Whited (2003) does in the context of investment. While not a substitute for studies focusing explicitly on the costs of adjusting (e.g., Altinkilic and Hansen (2000)), the hazard curve analysis is complimentary in the sense that it enables us to determine whether direct costs are reflected in the financing decisions of firms.

However, more important than the insight on adjustment costs, the duration model enables us to understand the motivation behind capital structure decisions by modelling the time between those decisions. As such, there is a very close relationship between duration models and discrete choice models. Therefore, it is not surprising that our results are broadly consistent with those of Hovakimian et al. (2001) who employ discrete choice models in their analysis of capital structure decisions, albeit with annual data. However, there are a number of advantages of the duration approach taken in this paper that we discuss below.

B. A Semiparametric Duration Model

Starting from the definition in equation (1), we parameterize the hazard function of the j^{th} spell for firm i as

$$h_{ij}(t|\omega_i) = \omega_i h_0(t) \exp\{x_{ij}(t)'\beta\}, \tag{2}$$

where ω_i is a random variable representing unobserved heterogeneity, $h_0(t)$ is a step function referred to as the baseline hazard, $x_{ij}(t)$ is a vector of covariates and β is an unknown parameter vector. As in Meyer (1990) and Whited (2003), we assume that the unobserved heterogeneity has a Gamma distribution and perform the estimation using maximum likelihood. A detailed derivation of the likelihood function is provided in the Appendix.

Intuitively, ω_i is analogous to an error term in a regression and, similarly, represents the cumulative effect of any omitted covariates. A key distinction between our specification, and Meyer's and Whited's is that we force the unobserved heterogeneity (ω_i) to remain constant across spells for the same firm in order to capture the dependence of within-firm observations. Meyer's model was of single spell unemployment data and hence each spell was assumed to be independent. The fact that ω_i is constant across adjustments made by the same firms generates a dependence between financing decisions made by the same firm. This assumption corresponds to the notion that durations between capital structure adjustments for the same firm are likely to be correlated. For example, a firm facing low costs of adjustment is more likely to experience shorter durations between adjustments and vice versa for firms facing high costs of adjustment.

The covariates ($x_{ij}(t)$) that we examine were outlined in section I and are guided both by earlier empirical research and the hypotheses that we wish to test. To avoid using information not yet known at the time of the adjustment decision, we lag all covariates one quarter except for the ratio of capital expenditures to book assets. We use the one period future value of this variable in order to capture anticipated financing needs, assuming that firms have a reasonably good idea of those needs over short horizons such as one quarter.

Table III presents summary statistics for each of the variables, after performing several modifications to address outlier values. First, we trim the upper and lower 1-percentile of each variable's distribution. Second, we restrict *leverage* to lie in the unit interval. Finally, we restrict the market-to-book ratio (*MA/BA*) to lie between 0 and 10, as in Baker and Wurgler (2002).[22] All variables, with the exception of *MA/BA* and *Z-Score* are measured in percentages. While most of the covariate characteristics are consistent with previous studies using these measures, the average and median estimated underwriter spreads are significantly inflated relative to that estimated by Altinkilic and Hansen (2000). This is, in large part, due to differences between their sample and ours. It also suggests that extrapolating their results outside of their sample should be done with caution. As such, we use estimates of the underwriter spread as a relative measure of issuance costs, as opposed to a precise measure of the exact costs.

[22]Using a maximal value for market-to-book of 20 produces no substantive change in our results.

At this point, it is worth discussing some of the advantages and limitations of this model. First, the model is dynamic; we are able to incorporate the complete time path of covariates into the model, rather than averaging covariates over time, as in a static discrete-choice setting. Given that the average is not likely to be a sufficient statistic for the temporal distribution of most variables, our method is more efficient than static discrete choice models and avoids any bias introduced by the data aggregation. An additional advantage of the dynamic nature of the model is that we avoid the inefficiency associated with two-step estimation procedures used in Hovakimian et al. (2001), Hovakimian (2003) and Korajczyk and Levy (2003), and the introduction of estimation error implicit in their estimates of target leverage. We are able to incorporate the determinants of optimal leverage directly into the specification, thereby implicitly modelling any deviation from an optimum, while estimating all parameters jointly in a maximum likelihood framework.

Second, we explicitly model dynamic financing decisions, as opposed to the time series variation in the level of leverage. As discussed earlier, leverage by itself can be a noisy measure of firms' financial policies. As Welch (2004) notes at an annual frequency and we confirm at a quarterly frequency, a large fraction of the time variation in the level of leverage stems from movements in the market value of equity, as opposed to active financial management. To determine the motives of financing decisions, we model the decision-making process, asking "why do firms adjust their leverage when they do?" Thus, we avoid potentially spurious correlations between the level of (or change in) leverage and its determinants that can result from most firm-quarter observations corresponding to periods of inactivity.

Third, the model retains the spirit of a nonparametric approach by specifying the baseline hazard, $h_0(t)$, as a step function. This ensures that our estimated hazard curves are not artifacts of an assumed functional form. The specification also addresses our two primary statistical concerns. Cross-sectional and longitudinal heterogeneity is captured both by observable variables ($x_{ij}(t)$) and unobservable firm characteristics (ω_i). Dependence among decisions made by the same firm is captured by assuming that the unobserved heterogeneity (ω_i) is constant across spells for the same firm.

Finally, we make several comments concerning interpretation of the estimated hazard function. The baseline hazard is a measure of the hazard function when all covariates are zero. Therefore all covariates are transformed by subtracting the median value across all firms for each quarter. This transformation enables the baseline hazard to be interpreted as the hazard rate for the median firm in our sample. We choose to center all continuous covariates around their medians, as opposed to their means, because of the skewness in many of the covariate distributions (see Table III).[23] The specification is analogous to Cox's (1972, 1975) proportional hazard in that variation in the covariates or unobserved heterogeneity result in proportional shifts of the baseline hazard. So, a change in a covariate instantly shifts the hazard curve up or down, depending on the sign of the estimated coefficient. However, this specification restricts the covariates from having any effect on the slope or curvature of the hazard curve. This restriction aids in the tractability of the model and simplifies the interpretation of estimated coefficients. In sum, the model is similar in spirit to a nonlinear dynamic panel regression with firm-specific random effects. It enables us to address the statistical concerns, while accurately testing the hypotheses laid out in section I.

IV. Estimation Results

For presentation purposes, we discuss our estimates of equation (2) in two parts. The first part corresponds to the implications of the estimated baseline hazard and adjustment cost proxy coefficients for capital structure adjustment costs. The second part corresponds to the implications of the other estimated covariate parameters for theories of capital structure.[24] Though presented separately, all parameters are estimated simultaneously using maximum likelihood.

A. Baseline Hazards and Adjustment Costs

Estimates of the baseline hazard ($h_0(t)$ in equation (2)) are presented in Figure 3. Each panel contains two estimates of the baseline hazard function: the jagged curve corresponds to the step function estimate and the smooth one to a cubic polynomial estimate.[25] Also presented in each panel are the parameter estimates and t-stats of the estimated cubic polynomial. Each point on the curve(s) may be loosely interpreted as the probability of an adjustment in that period, conditional on no prior adjustment.

[23]In unreported analysis, we center the covariates around their means and find little difference in the estimation results.

[24]There is an ancillary parameter of the model associated with the scale of the unobserved heterogeneity distribution, θ. This parameter is statistically significant in all of the estimated models suggesting that unobserved heterogeneity is present, beyond that captured by the hazard curve and covariates. This finding further reinforces the importance of accounting for such heterogeneity.

[25]Higher order polynomials were examined but resulted in insignificant coefficients and lower Akaike and Schwartz information criteria.

To mitigate the problem of a declining sample size as t increases, we define the width of each step in the baseline hazard function as corresponding to one decile of the duration distribution. The benefit of this approach is that each section of the hazard function has approximately the same number of observations, which permits more reliable statistical inference at longer durations. It also reduces the number of estimated parameters, leading to a more parsimonious model and increased statistical power. The cost of this approach is a decrease in the resolution of the hazard curve, particularly for larger t where more durations are grouped together. To ensure that our estimated hazard curves are not an artifact of this grouping, we reestimate all of the models assuming a step function where each step width is one quarter. The general features (slope and curvature) of these hazard curves are very similar to those in Figure 3 and, as such, the one-quarter width results are not presented.

A.1. Issuance Costs

Using Figure 2 as a reference point, we now examine the estimated hazard curves in order to determine if observed issuance decisions are consistent with the behavior implied by the cost functions estimated by Altinkilic and Hansen (2000). Altinkilic and Hansen document several empirical facts regarding issuance costs, as measured by underwriter spreads. First, equity issuance costs are, on average, 5.38% of the issue proceeds , while debt issuance costs average only 1.09%. This finding implies that equity issuances will occur less frequently than debt issuances, assuming firms minimize costs. Second, equity and debt issuance costs contain both a fixed cost and convex cost component. This finding implies that the estimated hazard curves should resemble Panel C of Figure 2. Finally, for similar firms, in terms of size and risk, equity issuance costs exhibit relatively higher fixed costs and greater convexity than debt issuances. The greater fixed cost implies that equity issuances will be relatively larger and less frequent, leading to lower and flatter hazard curves. However, the impact of greater convexity on the hazard curve is ambiguous.[26]

Turning to Figure 3, Panels A and B, we see that the general level of debt issuances is

[26]On the one hand, increasing the convexity of the cost curve increases the slope of the cost curve, which, all else equal, would lead to smaller issuances as each dollar issued is penalized more heavily. Simultaneously, the increased convexity results in a cost curve that lies strictly above the existing curve, which has an effect similar to increasing the fixed cost component. That is, issuances will be larger, all else equal. The net effect is thus ambiguous, requiring a structural model to determine which effect dominates.

noticeably higher than that for equity issuances, reflecting the greater frequency of debt issuances. The debt issuance hazard curve begins at approximately 0.13 and flattens out after approximately five years at just over 0.04. The equity issuance hazard, however, is below 0.04 for all durations. This result is consistent with significantly larger equity issuance costs, as found by Altinkilic and Hansen (2000).

We also see that both hazard curves are downward sloping for all durations. This fact is quantified by the slope coefficients of the cubic approximation presented in the inset boxes. Referring back to Figure 2, this result suggests that the cost structure is best approximated by either a proportional cost, or a fixed and weakly convex issuance cost. Because proportional costs imply minimal issuance sizes (see Panel B of Figure 1), when, in fact, relative issuance sizes are non-trivial (see Table II), we suspect that the estimated issuance hazard curves best reflect financing behavior in the presence of both a fixed and convex cost. This result is also consistent with the findings of Altinkilic and Hansen.

Turning to Panel B of Table IV, we now examine the estimated coefficients on the underwriter spreads in the debt and equity issuance models. Underwriter spreads enter the model by assuming that the relevant spread in any period is the actual spread for the next issuance. That is, we assume that the spread preceding any issuance is just the spread that is ultimately realized.[27] The debt issuance spread shows a significantly negative association, consistent with adjustment costs inhibiting debt issuances. Though not presented, credit ratings (measured by an indicator variable for investment grade debt) revealed a negative association with debt issuance, although the sample size is dramatically reduced due to missing data.

Equity issuance costs, though relatively larger than debt issuance costs according to the direct evidence (see, for example, Altinkilic and Hansen (2000)), show a positive association with the likelihood of issuance. This perverse result could be due to the extrapolation of Altinkilic and Hansen's equity underwriter spread estimates outside of their sample, which consists of significantly larger firms. Perhaps the underwriter spread for the smaller firms in our sample is determined by a different process than that found by Altinkilic and Hansen. Alternatively, the estimated spread may be capturing the effect of some other, omitted variable in the equity issuance specification.

With the exception of the equity issuance cost proxy, our results concerning issuance

[27]This definition creates the problem that censored durations do not have a spread since there is no issuance. Thus, we use the preceding realized spread or the firm-specific average spread for any censored observations. Our results are similar under both assumptions, so we present results for the former.

decisions appear generally consistent with the implications of the direct evidence on issuance costs. Costs are relatively larger for equity than debt, and both decisions behave as though facing a cost function consisting of both a fixed cost and convex cost of issuance.

A.2. Retirement Costs

Panel C of Figure 3 shows that equity repurchases have a steeply downward sloping hazard curve, similar to that in Panel B of Figure 2. This result suggests that equity repurchases are highly clustered in time, particularly relative to other capital structure adjustments. In light of the provisions of Rule 10b-18, this result is not surprising. Firms spread their equity repurchase decisions over the duration of the repurchase program in order to remain in accord with the Rule's provisions.[28] Examination of the estimated turnover coefficient in Panel B of Table IV shows evidence consistent with the adjustment cost interpretation, although statistically weak. Specifically, those firms experiencing greater share turnover during the quarter can more easily repurchase a larger fraction of their shares. As a result, these firms are more likely to engage in share repurchases.

The interpretation of the debt retirement hazard is confounded by the natural life cycle of debt securities. That is, the debt retirement decisions of firms may just be a consequence of the maturity structure of their debt. However, given that debt instruments are often retired prior to maturity, there may be relevant costs. For example, illiquidity in secondary bond markets makes repurchasing debt costly, particularly large amounts of debt. Retiring or refinancing commercial loans prior to maturity can also be costly because of penalties and/or bank fees. The estimated debt retirement hazard curve in Panel D shows that retirement decisions occur fairly frequently (the high level of the curve) and are clustered in time, but not to the extent of equity repurchases, for example. This dynamic behavior suggests a cost structure similar to that of equity issuances, but at a lower overall cost as indicated by the relative frequency of the two actions. Ultimately, whether this behavior is a consequence of the associated direct costs is left to future research. We now turn to tests of the trade-off theory.

[28]While Cook et al. (2003) find that firms do violate the repurchase provisions on occasion, they conclude that "...firms are generally in compliance with the safe harbor guidelines for all repurchasing activity." (P. 291)

B. The Trade-Off Theory

The estimates of the covariate coefficients (β) are reported in Table IV. Panel A presents the estimates for the two leverage adjustment spells (leverage increase and leverage decrease) and Panel B presents the estimates for the four basic financing spells (debt issuance, equity issuance, debt retirement, and equity repurchase) For presentation purposes, estimated fixed effects coefficients (industry, year and quarter) are not shown.

Interpretation of the coefficients is aided by the column labelled *Hazard Impact* (HI). This column transforms the parameters in the following manner:

$$\textit{Hazard Impact} = (\exp\{\beta\} - 1) \times 100, \tag{3}$$

The Hazard Impact gives the percentage change in the expected hazard rate for a one unit increase in the corresponding variable. For example, increasing *Leverage* by 1% (1 unit) decreases the debt issuance hazard by 0.80% ($(\exp\{-0.0081\} - 1) \times 100$), implying that the likelihood of a debt issuance, conditional on not having issued debt up to that point in time, decreases by 0.80%. For a binary variable, such as whether or not a leverage decrease (*LeverDown*) has occurred during a debt issuance spell, the hazard impact gives the percentage change in the hazard curve resulting from a change in state (from 0 to 1). So the hazard impact for *LeverDown* in the debt issuance model (44.41%) implies that after a firm decreases its leverage during a spell of debt issuance inactivity, the debt issuance hazard increases by 44.41%. That is, conditional on not having issued debt for some time, firms are approximately 44% more likely to issue debt after decreasing their leverage.

The evidence in support of the trade-off theory is quite strong; almost all of the empirical predictions are verified by our estimation results. We begin by examining the impact of market leverage on capital structure adjustments. Focusing on the leverage increase and decrease models in panel A of Table IV, we see that the level of and change in market leverage have a negative (positive) effect on the probability of making a leverage increasing (decreasing) change, even after controlling for other determinants. Firms with high leverage (relative to that implied by the included determinants), or with leverage that has been accumulating, are less likely to increase their leverage and more likely to decrease their leverage. These effects are both highly statistically and economically significant. A 1% increase in the level of leverage shifts down the leverage increase hazard curve by 0.76% and shifts up the leverage decrease hazard curve by 1.60%. Similarly, a 1% increase in the change in leverage shifts down the leverage increase hazard curve by 0.57% and shifts up the leverage increase hazard curve by the same amount. Thus, financing decisions are sensitive to both the level of and change in leverage. And, since both of these measures are constructed with market equity, financing decisions are also sensitive to any shocks to market equity that resonate through these measures.

Turning to panel B of Table IV, we see that debt policy is sensitive to the level of and change in leverage in a manner consistent with the trade-off theory. The estimated hazard impacts for the level of leverage in the debt issuance and retirement models are -0.80% and 1.83%, suggesting that firms are less likely to issue debt and even more likely to retire debt when their leverage is relatively high. Similarly, the change in leverage has a statistically significant impact on debt issuance and retirement decisions (hazard impacts of -0.44% and 0.63%, respectively). Equity repurchases are negatively related to the level of and change in leverage, as they should be if the trade-off theory is correct, although the coefficient on the change in leverage is statistically insignificant. These results are consistent with recent survey evidence on payout policy by Brav et al. (2003), who find that a number of firms say that they use equity repurchases to move their leverage ratio closer to a target, and that high debt firms are more likely to use equity repurchases to manage credit ratings (and implicitly leverage ratios) than low debt firms. Equity issuances, on the other hand, show no significant association with the level of or change in leverage. Thus, while firms rebalance their capital structure in response to the level of and change in leverage, they do so only through debt policy and equity repurchases.

Financing decisions are also sensitive to past financing decisions. Returning to the leverage increase model in panel A of Table IV, the binary variable *LeverDown* is one after a leverage decreasing adjustment occurs during a leverage increase spell and zero otherwise. The positive coefficient implies that when firms decrease their leverage, they are subsequently more likely to increase their leverage than they were before the decrease. The hazard impact suggests that they are 47% more likely to increase their leverage following the decrease. Analogously, when we examine the coefficient on *LeverUp* in the leverage decrease model, we see that firms are 65% more likely to decrease their leverage following leverage increasing actions. This sensitivity of leverage adjustments to previous financing decisions is precisely what Fischer et al.'s (1989) dynamic trade-off model predicts. After each adjustment, leverage is closer to, and thus more likely to strike, the opposite boundary than it was prior to the adjustment.

The debt and equity policy models in panel B reveal results that have similar implications to those of the level of and change in leverage. Firms rebalance their capital structures in response to past leverage increases and decreases using debt policy. The hazard impact for *LeverDown* in the debt issuance model implies that firms are 44%

more likely to issue debt after having decreased their leverage. Analogously, firms are 72% more likely to retire debt after having increased their leverage. The effect of *Lever-Down* on equity repurchases is directionally inconsistent, but statistically insignificant, with the prediction of the trade-off theory. Finally, past leverage increases have a significant positive effect on the likelihood of an equity issuance, consistent with the trade-off theory. Despite this consistency, we refrain from arguing that equity issuances are used as a tool for capital structure rebalancing because of the importance of other determinants in the equity issuance model, which we discuss below. So, while firms respond to past leverage adjustments, they do so primarily through debt policy.

In sum, firms appear to choose their financial policy in a manner that is consistent with the dynamic rebalancing implied by the trade-off theory. The level of leverage, change in leverage, and past financing decisions are all important determinants in future financing decisions; and their impact on those decisions coincides with a rebalancing effort by firms. Coupled with the evidence on adjustment costs, firms appear to behave as if attempting to maintain leverage within a desired range, as predicted by Fischer et al. (1989). Closer inspection reveals that firms actively rebalance their capital structure by issuing and retiring debt and, to a lesser extent, by repurchasing equity. Equity issuances, on the other hand, appear to be primarily driven by factors not associated with rebalancing efforts.

V. Alternative Theories of Capital Structure

The results presented above show that when firms make adjustments to their capital structure they do so, in large part, with rebalancing motives in mind. That said, we now turn to reconciling these findings with recent empirical works arguing both against dynamic rebalancing (Baker and Wurgler (2002) and Welch (2004)) and for pecking order behavior (Shyam-Sunder and Myers (1999) and Lemmon and Zender (2001)).

A. Market Timing

The fact that firms time markets in their security issuance decisions is well documented.[29] Our results in Panel B of Table IV confirm these earlier findings with the coefficient

[29]Taggart (1977), Marsh (1982), Asquith and Mullins (1986), Korajczyk et al. (1991), Jung et al. (1996), and Hovakimian et al. (2001) show a positive association between seasoned equity offerings and market valuations. Loughran et al. (1994) and Pagano et al. (1998) show a positive association between initial public offerings and market valuations. Ikenberry et al. (1995) show a negative association between equity repurchases and market valuations.

estimates on the cumulative 4-quarter stock return (*Equity Return*) and the market-to-book ratio (*MA/BA*). The hazard impact for the cumulative stock return in the equity issuance and repurchase models are 0.52% and -0.14%, respectively, both statistically significant. Market-to-book (MA/BA) has an even stronger positive association with the likelihood of an equity issuance (hazard impact of 21%), but a statistically insignificant association with the likelihood of an equity repurchase. However, the contention of Baker and Wurgler is that equity market timing has an important and lasting impact on corporate capital structure. Specifically, they argue that firms fail to rebalance their leverage after issuing equity in an attempt to time the market. Consequently, capital structure is solely the cumulative result of attempts to time equity markets and firms are no more or less likely to adjust their leverage in response to these timed equity issuances.

To test their hypothesis, Baker and Wurgler run several static cross-sectional regressions in IPO-time, regressing leverage on a number of empirical proxies for determinants of capital structure (e.g., profitability, size, etc.) and their "external finance weighted-average market-to-book ratio" (EFWA). This ratio is defined as:

$$\sum_{s=0}^{t-1} \frac{\text{Net Equity Issued}_s + \text{Net Debt Issued}_s}{\sum_{r=0}^{t-1} \text{Net Equity Issued}_r + \text{Net Debt Issued}_r} \cdot \left(\frac{\text{Market Value of Assets}_s}{\text{Book Value of Assets}_s} \right), \quad (4)$$

and is intended to capture historical equity market timing efforts. The statistical (and economic) significance of this variable over various horizons is interpreted as evidence that the effect of historical valuations is large and distinct from other determinants of capital structure. Baker and Wurgler continue by arguing that the effect is also persistent, showing that historical market-to-book variation remains a strong determinant of the cross-sectional variation in leverage ratios even after 10 years have passed. Thus, they conclude that firms do not rebalance their capital structure, as a dynamic trade-off theory would predict.

When one allows for dynamic optimization in the presence of adjustment costs, the implication of Baker and Wurgler's empirical finding is no longer clear. The negative association between EFWA and leverage implies that large values of EFWA (due both to large market-to-book ratios and corresponding equity issuances) are associated with low values of leverage. In other words, firms that have experienced relatively high historical values for market-to-book while simultaneously issuing equity tend to have relatively low values for current leverage. This finding, and its persistence over time, would seem to suggest that firms do not rebalance away shocks to leverage emanating from changes in the market-to-book ratio and equity issuances. Yet, as previously discussed, the persistence of shocks to leverage is not inconsistent with trade-off behavior in the presence of adjustment costs. The fact that firms are not responding immediately or fully to an equity shock/issuance may be due to subsequent leverage realizations lying in between the recapitalization boundaries. In addition to the evidence presented in the previous section, we perform several tests designed to further distinguish dynamic trade-off behavior from market timing.

A.1. Equity Issuers vs. Non-Issuers

We begin by explicitly looking at the leverage response of equity-issuing firms relative to non-equity issuing firms using the annual COMPUSTAT sample of Baker and Wurgler (2002).[30] Each year, the entire sample is stratified into four portfolios based on the median asset size of the firm (big and small) and the median market-to-book ratio of the firm (high and low). Within each of these portfolios, the sample is split between those firms that issued equity and those that did not, using the criteria described earlier. Holding the firms in these portfolios constant, we then track the average difference between the leverage of the issuers and non-issuers over the next five years. To clarify, in 1990, for example, we form four size/market-to-book portfolios, based on 1989 end-of-year characteristics, and compute the average difference in leverage between those firms that issued equity in 1990 and those that did not within each of the four portfolios. We follow these same portfolios of firms over the next five years, recomputing the difference in the leverage at each point in time. We also present the difference in leverage for these firms in the year prior to the issuance. We repeat this exercise for all other years in the sample (1975 to 1995) and then average across event times (i.e. start of the issue period, end of the issue period, one year after the issue period, etc.). The goal of this exercise is to determine if equity issuers in each of the four portfolios respond to the issuance by subsequently increasing their leverage relative to the non-issuers, which act as a control group.[31]

Panel A of Figure 4 presents the results. To clarify, small size, high market-to-book firms that issue equity have a leverage in the year preceding the issuance (indicated by

[30]We verified the similarity of our sample to Baker and Wurgler's by closely reproducing most of their major findings. We also note that all of the following analyses are also conducted using our sample of quarterly COMPUSTAT data and result in similar conclusions.

[31]We perform this analysis in two ways. First, we control for survivors so that the portfolios are unchanged for the entire period of observation (i.e. before the issuance through the following six years). These results are presented in figures 4 through 6. Second, we allow firms to drop out of the sample (e.g. due to bankruptcy). The results are unaffected.

"Pre") that is, on average, 1.25% higher than similar firms that do not issue equity. After the issuance (period "0"), the average leverage of the issuers is 3.60% lower than that of the non-issuers, reflecting the impact of the equity issuance. Immediately clear from the figure is that in the years following the equity issuance, the leverage of the equity issuers in each portfolio gradually increases relative to the non-issuers. Within two years of the issuance, big, high market-to-book firms have increased their leverage to above that of their non-issuing counterparts. Within four years, all four groups of equity issuers have rebalanced away any effects of the issuance, relative to their control group of non-issuers. Panel B shows that this increase in leverage among equity issuers is due to debt issuance activity. Panel B compares the fraction of equity-issuers, relative to non-issuers, that subsequently issue debt in each year after the equity issuance. The interpretation is that those firms that issue equity are subsequently more likely to issue debt, relative to similar non-issuing counterparts, in the years following the equity issuance. This is precisely what a dynamic trade-off hypothesis predicts, and what was illustrated by the duration model estimates presented in Table IV.

Figure 5 illustrates the Baker and Wurgler (2002) result, using a similar analysis to that presented in Figure 4. Each year four portfolios of firms are constructed based on size and market-to-book and the difference in leverage between firms with a high and low EFWA (above and below the median value for the year) is computed. These same portfolios are followed for five years and the average difference in leverage between these two groups is computed in each of those years. This exercise is repeated for all years in the sample and the leverage differences for each portfolio are averaged across event time. Panel A presents the results and shows that firms with a high EFWA tend to have relatively low leverage for an extended period.

The contrast in results between Panel A in Figures 4 and 5 suggest that EFWA may be capturing more than simply the impact of equity issuances. Using an approach inspired by the recent study of Kayhan and Titman (2003), Panels B, C and D replicate the analysis of Panel A, only comparing the leverage of groups distinguished by their past equally-weighted average market-to-book (high versus low), the number of times per year they have issued equity in the past (many versus few), and the size of past equity issuances (large versus small). As before, we use medians to distinguish between each group. Panel B shows that, in general, firms with a high historical average market-to-book tend to have persistently low leverage. However, when we compare the leverage of those firms that have done a lot of equity issuing with those that have not (Panel C), we see a negligible leverage difference that is eventually erased for all but one of the portfolios. Similarly, comparing firms that issue large and small amounts of equity reveals that differences in leverage are negligible and erased fairly quickly, except for small low market-to-book firms. Thus, the Baker and Wurgler result is not one of unresponsiveness to equity issuances (clear from Figure 4), but rather a natural tendency for firms with high average market-to-book to maintain low levels of leverage. And, as Kayhan and Titman note, high historical average market-to-book ratios likely indicate higher long-run growth opportunities, so that low leverage for these firms is, in fact, consistent with a trade-off theory.

A.2. Adjustment Costs and Market Timing

We next examine the impact that adjustment costs have on the empirical results of Baker and Wurgler (2002). Our dynamic trade-off model allows for persistence in the leverage process but suggests that this persistence may be mitigated for firms with low costs of adjustment. That is, firms with a relatively low cost of adjustment will be more likely to respond to shocks, all else equal, than firms with high costs of adjustment. Visually, low adjustment cost firms have recapitalization boundaries ($\underline{\mathrm{L}}$ and $\bar{\mathrm{L}}$ in Figure 1) that are relatively close together.

We can translate this prediction into the empirical framework of Baker and Wurgler by examining the impact of adjustment costs on the EFWA coefficient. For firms with very high (low) adjustment costs associated with debt issuances, we would expect the persistence in leverage to be high (low) and, consequently, the magnitude of this coefficient to be large (small). In effect, the coefficient on EFWA should attenuate with decreasing debt issuance costs because firms can more easily respond to any decrease in leverage induced by large values of EFWA.

Panel A of Table V presents our replication of Baker and Wurgler's estimated EFWA coefficient (their "All Firms" row of Panel A in Table 3). While not identical, the results are close enough to ensure that we have very closely approximated their sample selection and methodology. We then split their sample into portfolios based on each of our three different debt issuance adjustment cost proxies: estimated underwriter spread, Altman's Z-Score, and debt credit rating. For the first two proxies, the portfolios are formed based on the lower, middle, and upper third of the proxy distribution. For the credit rating proxy, we form two portfolios based on an above or below investment-grade credit rating. The same regression from Panel A is then run separately on each portfolio. The results are presented in Panel B of Table V.

Uniformly across adjustment cost portfolios, the coefficient on EFWA attenuates as the cost of issuing debt decreases. This result holds for all three proxies, with the exception of a negligible difference between the medium and high cost groups for the Z-score proxy. We then conduct paired t-tests, for each cost proxy, of the hypothesis that the coefficients in the high and low cost portfolios are the same, against the alternative hypothesis that the coefficient in the low cost portfolio is lower. For estimated spreads and credit ratings, the differences are highly statistically significant with t-stats of -6.62 and -2.16. For Z-score, the difference is still statistically significant (t-stat of -1.84), though slightly less so than the other comparisons. These results show that for firms for which adjustment is relatively inexpensive, leverage is less persistent in the context of Baker and Wurgler's model, a result counter to the implications of market timing but consistent with the dynamic trade-off model.

A.3. The Impact of Stock Issuances and EFWA on Rebalancing Decisions

Our next set of tests examines the impact of stock issuances and the EFWA variable in the context of our duration model. According to the trade-off theory, stock issuances should increase the likelihood of a leverage increasing adjustments, as they correspond to leverage moving closer to the lower recapitalization boundary. EFWA, however, would only have an indirect effect in so far is it is correlated with leverage and past equity issuances. Therefore, we would not expect EFWA to have much incremental explanatory power beyond those variables already included in the model. Thus, after incorporating each of these variables into our debt issuance and leverage increase models, the trade-off theory makes two predictions. First, and most important, the rebalancing results found earlier are unaffected by the inclusion of these variables. Second, if stock issuances or EFWA have any association with financing decisions, it is consistent with a rebalancing effort by firms.

We implicitly examined the response of firms to stock issuances in Table IV, since the *LeverDown* variable encompasses stock issuances. In order to focus exclusively on stock issuances, we create a binary variable indicating whether a stock issuance has occurred during the relevant spell (debt issuance or leverage increase). Columns 1 and 3 of Table VI replace the *LeverDown* variable with this stock issuance variable. In both the debt issuance and leverage increase models, the coefficients are positive, consistent with the trade-off theory, but marginally significant with t-stats of 1.80 and 1.59, respectively. This is not surprising since stock issuances represent a small fraction of the leverage decreasing adjustments, so that the *StockIss* variable is less significant that the *LeverDown* variable.

More importantly, the level of and change in leverage are unaffected by the inclusion of this variable so that the rebalancing results from Table IV remain intact. When we include the EFWA variable, it has no association with either debt issuance or leverage increasing decisions (columns 2 and 4 of Table VI). Further, the rebalancing results are all unaffected by the inclusion of EFWA.

As a final note, we recognize the multicollinearity between the level of leverage, EFWA, the market-to-book ratio and stock issuances. Any attempts to treat this collinearity by removing one or more variables only served to further reinforce the rebalancing results.

A.4. The Duration of Responses to Stock Issuances

Our last examination of the market timing hypothesis consists of estimating how long it takes for firms to adjust their capital structure in response to stock issuances. Above, we noted that the effect of an equity issuance on leverage is largely erased within two years. We now compute a more formal estimate of this response time using our duration framework.

Ideally, we would like to estimate the expected time from a stock issuance until the next leverage-increasing adjustment occurs, using our results from the model presented in Table VI. Unfortunately, this is an exceedingly complex task because of the dynamic nature of our model.[32] Instead, we compute this estimate using a slightly less complex model that is similar in spirit to that presented in equation (2). We estimate the following model:

$$h(t) = \omega_i h_0(t) \exp\{\alpha\}, \tag{5}$$

where duration now measures the time between a stock issuance and a leverage increasing adjustment. As before, ω_i is an unobserved heterogeneity term with a Gamma distribution, and $h_0(t)$ is the unspecified baseline hazard. The key distinction between equations (2) and (5) is that the latter has no time-varying covariates, $x_{ij}(t)$, and as such is a static model. Maximum likelihood estimation reveals that the median (average) time that it takes a firm to increase its leverage in response to a stock issuance is 4.4 (8.6) quarters. Note the consistency of this estimate with the results in Panel A of Figure 4. Thus, while firms do not respond *immediately* to stock issuances, possibly because of adjustment costs, they do respond within a reasonably short time frame.

[32]Computation of the expected duration in our model (equation (2)) requires integration of the full hazard, $h(t)$, and then integration of the resulting duration density, $f(t) = h(t) \exp\{-\int h(s)\}$.

B. Inertia

The inertia theory (Welch (2004)) argues that firms fail to rebalance their capital structure in response to shocks to the market value of their equity, similar to the implication of market timing, despite fairly active net issuing activity. Thus, Welch concludes that variation in equity prices are the primary determinant of capital structure and "corporate motives for capital structure relevant activities remain largely a mystery" (p. 20). To test this theory, Welch uses OLS and the Fama-MacBeth (1973) method to estimate the following model of leverage dynamics:

$$\frac{D_{t+k}}{D_{t+k}+E_{t+k}} = \alpha_0 + \alpha_1 \cdot \frac{D_t}{D_t+E_t} + \alpha_2 \cdot \frac{D_t}{D_t+E_t \cdot (1+r_{t,t+k})} + \varepsilon_t, \qquad (6)$$

where D_t is the book value of corporate debt, E_t is the market value of equity, and $r_{t,t+k}$ is the percent price change in the market value of equity between t and $t+k$. The inertia hypothesis predicts that $\alpha_1 = 0$ and $\alpha_2 = 1$, implying that any change in leverage between t and $t+k$ is due to changes in the market value of equity over that period, as opposed to adjustment to the start-of-period leverage ratio. Welch finds that, over various time horizons, $\hat{\alpha_2}$ is close to one and dominates any other terms in the regression, including alternative proxy variables (e.g., profitability, marginal tax rate, etc.) used in an expanded specification. Thus, Welch concludes that firms fail to rebalance their capital structures, even over horizons as long as five years.

However, similar to market timing, the inertia theory is predicated on the persistence in leverage. And, as discussed before, persistence in leverage is insufficient to reject trade-off behavior. The remainder of this subsection sets out to distinguish the trade-off behavior examined in this paper from the inertia theory.

B.1. The Response to Large Equity Shocks

Our first examination is very similar to that presented in Figure 4. Using an annual COMPUSTAT sample selected to match the one used in Welch (2004), we stratify the sample each year into four portfolios based on firm size and market-to-book medians.[33] We then compare the average leverage of those firms that experience a "large" positive (negative) equity shock, defined as an equity return at least one standard deviation above (below) the firm-specific average return, to those that did not.[34] We perform the

[33] To ensure that our sample closely resembles that used by Welch (2004), we closely reproduce a number of his results.

[34] We also alter the definition of a large equity shock to coincide with a 1.5 and 2 standard deviation return with little effect on our results.

comparison in the year preceding the shock (period "Pre"), the year of the shock (period 0), and the following five years. Panel A of Figure 6 looks at the response to positive equity shocks; panel C of Figure 6 looks at the response to negative equity shocks.

Several observations are worth noting. First, leverage noticeably decreases (increases) in response to the positive (negative) equity shock during the year of the shock suggesting that firms do not respond simultaneously with the shock. Implicit in Welch's empirical test (equation (6)) is the assumption that firms respond simultaneously to equity shocks, thereby immediately returning their leverage to its pre-shock level (last period's leverage). Hence, Figure 6 illustrates why $\hat{\alpha_2}$ is approximately equal to 1 and $\hat{\alpha_1}$ approximately equal to 0 in equation (6). Second, the response to equity shocks is gradual, in the sense that more and more firms respond over the subsequent five years. This fact explains why $\hat{\alpha_2}$ attenuates and $\hat{\alpha_1}$ increases as k, the time between periods, increases. As time goes by since the equity shock, the leverage of those experiencing the shock approaches the leverage of those that did not (i.e. the control group). This result highlights the persistence, on which the inertia theory is predicated. The response to equity shocks occurs gradually over time.

However, Panels A and C clearly show a response to the equity shock. Panels B and D of Figure 6 confirm that the leverage adjustment is the result of firms actively responding to the equity shock via debt policy. Firms experiencing a positive shock are more likely to subsequently issue debt (Panel B), while firms experiencing a negative shock are more likely to subsequently retire debt (Panel D). Thus, Figure 6 illustrates that firms do indeed respond to equity shocks in so far as they impact leverage, consistent with the findings in Table IV.

B.2. Simulated Trade-off Data

Because the specification in equation (6) requires knowledge of only debt and equity values, along with capital gains, we are able to estimate the model using data simulated from the trade-off model of Fischer et al. (1989). More specifically, we simulate 100 annual observations of debt and equity values using their model with the following parameter values: a corporate tax rate of 50%, a personal tax rate of 35%, an asset value variance of 5%, a transaction cost of 1%, a riskless interest rate of 2%, and a fractional value loss in bankruptcy of 20%. All of these parameters are "base case" values, except for the cost of bankruptcy (base case value of 5%). We employ their model under this higher bankruptcy cost in order to ensure that leverage adjustments occur in both directions (increases and decreases), which is consistent with the data.

Using the simulated debt and equity data, the model in equation (6) is estimated using OLS. This procedure of simulating data and estimating equation (6) is repeated 500 times, producing a series of parameter estimates $(\alpha_0, \alpha_1, \alpha_2)$ and R-squareds (R^2). Table VII presents the means of the parameters and R-squareds. Also presented is a reproduction of the results from Panel B of Table 3 in Welch (2004). Immediately clear is the similarity of the results generated from the simulated data and that from the actual data used by Welch. For the one-period regression, α_2 is approximately one and α_1 is negative and much smaller in magnitude. The intercept and α_1 both increase with the horizon, while α_2 and the R-squared decrease with the horizon.

In fact, the only distinction is that the magnitude of the coefficients and R-squareds corresponding to the simulated data are lower than those for the actual data at longer horizons. This difference is due to greater persistence in the actual data relative to the simulated data and is unsurprising when considered in the context of our results on adjustment costs. We showed earlier that leverage behaves as though firms face adjustment costs, debt issuance costs in particular, that are likely comprised of fixed and convex cost components. Thus, the actual leverage data resembles that shown in Panel C in figure 1. The simulated data is generated assuming a fixed cost and thus resembles that shown in Panel A. The relevant distinction between these two processes is that the simulated data exhibits less persistence than the actual data, so that shocks dissipate more quickly in the simulated data. Hence, the parameter estimates (and R-squareds) based on the simulated data decline more rapidly than those using the actual data.

C. The Pecking Order

The pecking order, formalized by Myers and Majluf (1984) and Myers (1984), states that firms have a preference ranking over sources of funds for financing based on the corresponding information asymmetry costs. Internal funds avoid such costs entirely and, as such, are at the bottom of the pecking order. This source is followed by riskless and then risky debt. Finally, equity is at the top of the pecking order as a residual source of financing.

Table IV shows two key results consistent with this theory. First, firms with large internal equity or large cash balances are less likely to use external financing. This result is represented by the negative coefficients on the *Cash* and *Profitability* variables in the debt and equity issuance models. Second, firms with large capital expenditures (*CapEx(t+1)*) are more likely to issue debt or equity. Further, the negative coefficient on profitability in the debt issuance model casts some doubt on the traditional static trade-off view that firms use debt as a tax shield for operating profits or to mitigate free cash-flow problems.

These results are, perhaps, not surprising given the history of empirical evidence consistent with aspects of both the trade-off and pecking order theories (e.g. Titman and Wessels (1988) and Fama and French (2002)). Though typically viewed as competing theories, the trade-off and pecking order do share some theoretical commonalities, particularly when one considers the "modified" pecking order described in the conclusion of Myers (1984). In this version, Myers notes that firms take into account the financial distress costs of debt financing with the information asymmetry costs of equity financing. Recent empirical evidence (Shyam-sunder and Myers (1999) and Lemmon and Zender (2002)) tends to support this version of the pecking order.

The modified pecking order and the trade-off model examined here have similar predictions for the dynamics of capital structure adjustments. As leverage increases, firms are more likely to issue equity or repurchase debt to avoid bankruptcy costs and preserve future debt capacity, but don't do so immediately due to the costs of the adjustment. Similarly, as leverage decreases, debt capacity increases. Firms are then more likely to fund investment opportunities by issuing debt, but may still refrain from doing so (by using internally generated funds) due to the direct costs (and information costs in the case of risky debt) of external security issuance. Our tests, being primarily designed to detect such rebalancing behavior, have low power to distinguish this scenario from a more traditional tax-bankruptcy cost tradeoff model. Thus, while our results suggest that information asymmetry costs may be an important concern in firms' financing decisions, future research focused explicitly on the predictions of the pecking order are required for a clearer distinction between the pecking order and traditional trade-off theories.

VI. Conclusion

We analyze whether corporate financial policy is consistent with the trade-off theory, after accounting for costly adjustment. We begin by showing that firms tend to make capital structure adjustments relatively infrequently (on average once a year) but in clusters. This temporal pattern in financing decisions is largely consistent with the direct evidence describing the adjustment costs associated with financing decisions.

Motivated by the theoretical framework of Fischer et al. (1989), we illustrate how shocks to leverage can have a persistent effect when firms are faced with adjustment costs, implying that leverage is a noisy measure of firms' financial policies. We then specify a dynamic duration model of firms financing decisions, in order to understand the motivation behind actual leverage adjustments (i.e. why do firms adjust when they do). Our results are strongly supportive of a rebalancing effort by firms, consistent with a dynamic trade-off theory. However, our results are inconsistent with the market timing and inertia theories, both of which are predicated in large part on the persistence of the leverage process. Firms do indeed respond to equity issuances and equity price shocks by appropriately rebalancing their leverage over the next one to four years. Thus, the persistent effect of shocks on leverage documented by previous studies (e.g., Baker and Wurgler (2002) and Welch (2004)) is more likely due to optimizing behavior in the presence of adjustment costs, as opposed to market timing or indifference.

Interestingly, we also find evidence consistent with the predictions of the pecking order in that firms are less likely to utilize external capital markets when they have sufficient internal funds, but are more likely when they have large investment needs. Thus, while firms appear to follow a dynamic rebalancing strategy, information asymmetry costs may be an important determinant in their financing decision. However, since our tests are designed primarily to detect rebalancing behavior, as opposed to distinguish trade-off and pecking order behavior, further work on this distinction is needed.

Appendix: Likelihood Function

Let T_{ij} be a random variable corresponding to the duration of the j^{th} capital structure adjustment for firm i and define $F_{ij}(t)$ and $f_{ij}(t)$ to be the corresponding distribution and density functions, respectively. Also define the survival function, $S_{ij}(t) = 1 - F_{ij}(t)$, and note that, from the definition of the hazard function in equation (1), $h_{ij}(t) = f_{ij}(t)/S_{ij}(t)$. The survivor function will prove useful in expressing the likelihood function.

Recall the conditional hazard specification in equation (2):

$$h_{ij}(t|\omega_i) = \omega_i h_0(t)\exp\{x_{ij}(t)'\beta\}, \tag{7}$$

where ω_i is a random variable representing unobserved heterogeneity, $h_0(t)$ is a step function referred to as the baseline hazard, $x_{ij}(t)$ is a vector of covariates and β is an unknown parameter vector. To ease the discussion, we define $h_{ij}(t) = h_0(t)\exp\{x_{ij}(t)'\beta\}$, which enables us to write the conditional hazard more compactly as

$$h_{ij}(t|\omega_i) = \omega_i h_{ij}(t). \tag{8}$$

From their definitions, the hazard and survival functions are related by:

$$h_{ij}(t|\omega_i) = \frac{-d\ln S_{ij}(t|\omega_i)}{dt}. \tag{9}$$

Given this relation,

$$\begin{aligned} S_{ij}(t|\omega_i) &= \exp\left\{\int_0^t h_{ij}(u|\omega_i)du\right\} \\ &= \exp\left\{-\omega_i\int_0^t \frac{f_{ij}(u)}{S_{ij}(u)}du\right\} \\ &= [S_{ij}(t)]^{\omega_i} \end{aligned} \tag{10}$$

where $S_{ij}(t)$ is the survival function corresponding to $h_{ij}(t)$.

To obtain the likelihood function, we compute the firm-level conditional likelihoods and then integrate out the random variable ω_i. Assume that we have $i = 1, ..., N$ firms, each with $j = 1, ..., n_i$ observations consisting of a start time (t_{0ij}), an end time (t_{ij}), and a adjustment indicator:

$$d_{ij} = \begin{cases} 1 & \text{if adjustment occurs} \\ 0 & \text{if censored} \end{cases} \tag{11}$$

Note that while a financing duration may last several quarters, for the purpose of estimation we model each observation as a separate duration that either ends in a financing spike, in which case $d_{ij} = 1$, or is censored, in which case $d_{ij} = 0$. This allows us to use information on the complete time path of covariates in our estimation. Though not explicit, the hazard and survival functions are both conditional on the observed covariates, $x_{ij}(t)$.

The conditional likelihood contribution of the j^{th} spell for the i^{th} firm is given by

$$\begin{aligned} L_{ij}(\omega_i) &= \frac{S_{ij}(t_{ij}|\omega_i)}{S_{ij}(t_{0ij}|\omega_i)} h_{ij}(t_{ij}|\omega_i)^{d_{ij}} \\ &= \left[\frac{S_{ij}(t_{ij})}{S_{ij}(t_{0ij})}\right]^{\omega_i} [\omega_i h_{ij}(t_{ij})]^{d_{ij}} \end{aligned} \tag{12}$$

where the second equality follows from the relation in equation (10). Conditional on the unobserved heterogeneity, each observation for the i^{th} firm is independent. Thus, the likelihood contribution for the i^{th} firm, conditional on the unobserved heterogeneity, is:

$$L_i(\omega_i) = \prod_{j=1}^{n_i} \left[\frac{S_{ij}(t_{ij})}{S_{ij}(t_{0ij})}\right]^{\omega_i} [\omega_i h_{ij}(t_{ij})]^{d_{ij}} \tag{13}$$

The unconditional likelihood function for the i^{th} firm is

$$L_i = \int L_i(\omega_i) dG(\omega_i), \tag{14}$$

where $G(\omega_i)$ is the distribution function of ω_i. When $G(\omega_i)$ is a gamma distribution with mean one and variance θ, the unconditional log-likelihood contribution for the i^{th} firm is equal to[35]

$$\begin{aligned} \ln L_i &= \sum_{j=1}^{n_i} d_{ij} \ln h_{ij}(t_{ij}) - (\theta^{-1} + D_i) \ln \left[1 - \theta \sum_{j=1}^{n_i} ln \frac{S_{ij}(t_{ij})}{S_{ij}(t_{0ij})}\right] \\ &+ D_i \ln \theta + \ln \Gamma(\theta^{-1} + D_i) - \ln \Gamma(\theta^{-1}) \end{aligned} \tag{15}$$

where $D_i = \sum_{j=1}^{n_i}$ is the number of adjustments made by firm i and $\Gamma(\cdot)$ is the gamma function. When we assume that ω_i is distributed inverse Gaussian with a mean of one and variance of θ, the unconditional log-likelihood contribution of the i^{th} firm is

$$\ln L_i = \theta^{-1}\left(1 - R_i^{-1}\right) + B(\theta R_i, D_i) + \sum_{j=1}^{n_i} d_{ij} \left[\ln h_{ij}(t_{ij}) ln R_i\right] \tag{16}$$

[35]See Gutierrez (2002).

where

$$R_i = \left[1 - 2\theta \sum_{j=1}^{n_i} \ln \frac{S_{ij}(t_{ij})}{S_{ij}(t_{0ij})}\right]^{0.5}$$

and $B(x, y)$ is defined as

$$B(x, y) = x^{-1} + 0.5\left[\ln(2\pi^{-1}) - \ln(x)\right] + \ln\left(Bk(0.5 - y, x^{-1})\right).$$

$Bk(a, b)$ is known as the BesselK function (see Wolfram (1999)). The complete unconditional log-likelihood is obtained by simply summing equation (15) or (16) over the i firms.

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Table I

Capital Structure Adjustment Summary Statistics

The sample consists of quarterly COMPUSTAT data from 1984 to 2001 and is restricted to firms with at least four years of contiguous data and no missing values for equity issuances, equity repurchases, long term debt, short term debt or book assets. Financial firms (SICs 6000-6999) and utilities (SICs 4900-4999) are excluded. The table presents summary information on four basic financing spikes (Debt Issue, Debt Retirement, Equity Issue, Equity Repurchase) and two leverage adjustments (Leverage Increase and Leverage Decrease). The basic financing spikes are defined as a net security issuance or repurchase of at least 5% of book assets. The leverage adjustments are defined as a difference in net debt issued and net equity issued that is greater in magnitude than 5% of book assets. The duration measures the time, in quarters, between financing spikes or leverage adjustments of the same type. Right-censored spells is the number of financing spikes or leverage adjustments with a duration that is right-censored. There are a total of 127,308 firm-quarter observations and the average firm has approximately 36 quarterly observations.

	Number of	Percent of	Right Censored	Median	Adjustments Per Firm			
Adjustment Type	Adjustments	Periods	Spells	Duration	Mean	Min	Median	Max
No Adjustment	92,159	72.39%	–	–	–	–	–	–
Debt Issue	16,021	12.58%	3,114	3	4.19	0	3	41
Debt Retirement	10,920	8.58%	3,087	4	2.80	0	2	23
Equity Issue	6,867	5.39%	3,344	5	1.88	0	1	30
Equity Repurchase	5,723	4.50%	3,390	3	2.81	0	1	43
Leverage Increase	16,385	12.87%	3,122	3	4.23	0	3	41
Leverage Decrease	15,113	11.87%	2,977	4	3.73	0	3	27

Table II
Capital Structure Adjustment Magnitudes

The sample consists of quarterly COMPUSTAT data from 1984 to 2001 and is restricted to firms with at least four years of contiguous data and no missing values for equity issuances, equity repurchases, long term debt, short term debt or book assets. Financial firms (SICs 6000-6999) and utilities (SICs 4900-4999) are excluded. The table presents summary information on the magnitude of four basic financing spikes: Debt Issue, Debt Retirement, Equity Issue, and Equity Repurchase, each defined as a net security issuance or repurchase of at least 5% of book assets. All dollar values are in millions and inflation adjusted to 2001 dollars using the all urban CPI. The top one percentile of each variable's distribution is trimmed.

		Median	Mean	Std Dev
Debt Issue	Issue Size	7.81	54.48	147.66
	Book Assets	76.33	504.03	1491.57
	Issue Size / Book Assets	0.0967	0.1562	0.1677
	Issue Size / Market Capitalization	0.1233	0.2278	0.3256
Debt Retirement	Retirement Size	6.62	44.42	120.06
	Book Assets	66.12	498.93	1534.71
	Retirement Size / Book Assets	0.0898	0.1314	0.1192
	Retirement Size / Market Capitalization	0.1521	0.4021	0.8259
Equity Issue	Issue Size	3.55	19.93	42.42
	Book Assets	15.14	154.03	597.65
	Issue Size / Book Assets	0.1968	0.4076	0.5832
	Issue Size / Market Capitalization	0.0907	0.1426	0.1655
Equity Repurchase	Repurchase Size	11.20	55.90	112.46
	Book Assets	348.22	1661.63	3142.95
	Repurchase Size / Book Assets	0.0253	0.0365	0.0322
	Repurchase Size / Market Capitalization	0.0209	0.0321	0.0353

Table III
Summary Statistics of Financing Decision Determinants

The sample consists of quarterly COMPUSTAT data from 1984 to 2001 and is restricted to firms with at least four years of contiguous data and no missing values for equity issuances, equity repurchases, long term debt, short term debt or book assets. Financial firms (SICs 6000-6999) and utilities (SICs 4900-4999) are excluded. All variables are expressed in percentages (except MA/BA and Z-Score) and are normalized by the contemporaneous book value of total assets unless otherwise noted. *MA/BA* is the ratio of the book value of assets minus book equity plus market equity to the book value of assets. *Leverage* is the ratio of total debt to the sum of total debt and the market value of equity. *Size* is the ratio of sales for firm i in quarter t to the sum of sales for all firms in quarter t. *CapEx* is capital expenditures. *Cash* is cash and short-term marketable securities. *DepAmort* is depreciation and amortization. *Tangibility* is physical plant, property and equipment. *Profitability* is net operating income. *Selling Expense* is selling expenses as a fraction of sales. *Volatility* is the absolute value of the change in net income. *Z-Score* is the sum of 3.3 times earnings before interest and taxes plus sales plus 1.4 times retained earnings plus 1.2 times working capital, all divided by total assets. *Equity Return* is the cumulative four-quarter stock return. *Underwriter Spreads* are calculated using estimated equations for debt and equity issuance spreads from Altinkilic and Hansen (2000). *Turnover* is the maximum daily share turnover during the quarter. *Leverage* is restricted to lie in the unit interval. *MA/BA* is restricted to be less than 10. The upper and lower one-percentiles of all other variables are trimmed.

Variables	Median	Mean	Standard Deviation
MA / BA	1.36	1.84	1.38
Leverage	17.91	24.80	24.45
Size	0.008	0.058	0.197
CapEx	1.14	1.75	1.99
Cash	5.54	13.46	17.84
DepAmort	1.18	1.37	0.91
Tangibility	25.61	31.45	22.70
Profitability	3.04	1.87	5.77
Selling Expense	23.74	31.51	32.76
Volatility	0.86	2.05	3.45
Z-Score	0.91	0.37	2.14
Equity Return	1.00	8.58	52.55
Underwriter Spread (Debt Issuance)	5.71	21.82	148.12
Underwriter Spread (Equity Issuance)	10.92	34.34	105.12
Turnover	1.50	3.10	8.00

Table IV
Determinants of Financing Decisions

The sample consists of quarterly COMPUSTAT data from 1984 to 2001 and is restricted to firms with at least four years of contiguous data and no missing values for equity issuances, equity repurchases, long term debt, short term debt or book assets. Financial firms (SICs 6000-6999) and utilities (SICs 4900-4999) are excluded. All variables are normalized by total assets and measured at time $t-1$ unless otherwise noted. *Size* is the ratio of sales for firm i in quarter t to the sum of sales for all firms in quarter t. *MA/BA* is the ratio of total assets minus book equity plus market equity to total assets. *CapEx (t+1)* is capital expenditures in quarter $t+1$. *Cash* is cash and short-term marketable securities. *DepAmort* is depreciation and amortization. *Tangibility* is the value of tangible assets. *Profitability* is net operating income. *Volatility* is the absolute value of the change in net income. *Z-Score* is the sum of 3.3 times earnings before interest and taxes plus sales plus 1.4 times retained earnings plus 1.2 times working capital, all divided by total assets. *Selling Expense* is selling expenses as a fraction of sales. *Equity Return* is the cumulative four-quarter stock return. Δ*Leverage* is the change in leverage. *Leverage* is the ratio of total debt to the sum of total debt and the market value of equity. *LeverDown* is a binary variable equal to one after a leverage decreasing event occurs during a spell. *LeverUp* is a binary variable equal to one after a leverage increasing event occurs during a spell. *Estimated Spreads* represents the estimated underwriter spread for the issuance that ends each spell, calculated using estimated equations for debt and equity issuance spreads from Altinkilic and Hansen (2000). For right censored spells, this is replaced by the estimated spread for the issuance or repurchase that ended the previous spell; *Turnover* is the maximum daily turnover during the quarter. Binary variables corresponding to years, quarters and 2-digit SIC codes are included in the estimation but not reported. The hazard impact (HI) is defined as: $100 \times (\exp\{\beta\} - 1)$, where β is the estimated coefficient, and measures the percentage shift in the hazard curve due to a 1-unit change in the covariate. t-statistics are presented in parentheses below the corresponding estimate. Statistical significance at the 1% (5%) level is indicated by two (one) asterisks.

Panel A: Leverage Adjustments

	Leverage Increase		Leverage Decrease	
Coefficient	Estimate	HI (%)	Estimate	HI (%)
Size	-0.0031**	-0.31	-0.0094**	-0.94
	(-2.72)		(-5.03)	
MA / BA	0.0379*	3.87	0.1868**	20.54
	(2.5)		(13.06)	
CapEx (t+1)	0.0804**	8.37	0.0021	0.21
	(15.64)		(0.27)	
Cash	-0.0278**	-2.74	-0.0152**	-1.51
	(-17.67)		(-9.85)	
DepAmort	-0.06**	-5.82	0.0417	4.26
	(-2.94)		(1.92)	
Tangibility	-0.0034**	-0.34	-0.0116**	-1.16
	(-3.27)		(-9.27)	
Profitability	-0.0245**	-2.42	-0.0004	-0.04
	(-5.29)		(-0.1)	
Volatility	0.0072	0.72	0.0221**	2.24
	(1.42)		(4.53)	
Z score	0.0000	0.00	-0.0008**	-0.08
	(0.24)		(-6.6)	
Selling Expense	0.0004	0.04	0.0013*	0.13
	(0.62)		(2.01)	
Equity Return	0.0004	0.04	0.0023**	0.23
	(1.37)		(8.05)	
Δ Leverage	-0.0057**	-0.57	0.0057**	0.57
	(-2.94)		(2.82)	
Leverage	-0.0076**	-0.76	0.0159**	1.60
	(-8.83)		(18.02)	
LeverDown	0.3855**	47.03		
	(12.03)			
LeverUp			0.5023**	65.26
			(12.77)	

Panel B: Basic Financing Spikes

	Debt Issuance		Equity Issuance		Debt Retirement		Equity Repurchase	
Coefficient	Estimate	HI (%)	Estimate	HI (%)	Estimate	HI (%)	Estimate	HI (%)
Size	-0.0079**	-0.79	-0.0358**	-3.52	-0.0073**	-0.73	0.0063**	0.63
	(-5.64)		(-4.62)		(-3.55)		(5.21)	
MA / BA	0.0206	2.08	0.1934**	21.33	0.1098**	11.61	0.0431	4.40
	(1.29)		(10.28)		(5.03)		(1.64)	
CapEx (t+1)	0.0869**	9.08	0.0499**	5.12	-0.0287**	-2.83	-0.0374*	-3.67
	(16.83)		(5.08)		(-2.76)		(-2.53)	
Cash	-0.0359**	-3.52	-0.0161**	-1.59	-0.0204**	-2.02	0.0084**	0.84
	(-19.93)		(-7.1)		(-8.97)		(4.43)	
DepAmort	-0.06**	-5.82	0.0717*	7.43	0.0241	2.44	-0.0138	-1.37
	(-2.9)		(2.09)		(0.88)		(-0.32)	
Tangibility	-0.004**	-0.40	-0.0054*	-0.54	-0.0134**	-1.33	0.0032	0.32
	(-3.75)		(-2.55)		(-8.77)		(1.55)	
Profitability	-0.0313**	-3.08	-0.0265**	-2.62	0.0129*	1.30	0.0305*	3.10
	(-6.82)		(-3.7)		(2.19)		(2.4)	
Volatility	0.0029	0.29	-0.0063	-0.62	0.0357**	3.64	0.0065	0.65
	(0.56)		(-0.72)		(6.13)		(0.51)	
Z-score	-0.0003*	-0.03	-0.0012**	-0.12	-0.0004*	-0.04	0.0015**	0.15
	(-2.38)		(-6.91)		(-2.19)		(3.12)	
Sell Exp	0.0007	0.07	0.0004	0.04	0.0002	0.02	-0.004*	-0.40
	(1.16)		(0.48)		(0.21)		(-2.28)	
Equity Return	0.0009**	0.09	0.0051**	0.52	0.0015**	0.15	-0.0014**	-0.14
	(3.48)		(11.28)		(4.21)		(-2.59)	
Δ Leverage	-0.0044*	-0.44	-0.0071	-0.71	0.0063**	0.63	-0.0024	-0.24
	(-2.26)		(-1.65)		(2.79)		(-0.49)	
Leverage	-0.0081**	-0.80	0.0020	0.20	0.0181**	1.83	-0.018**	-1.78
	(-9.07)		(1.06)		(17.01)		(-8.95)	
LeverDown	0.3675**	44.41					-0.0177	-1.76
	(11.41)						(-0.34)	
LeverUp			0.2525**	28.73	0.5439**	72.28		
			(3.68)		(12.24)			
Estimated Spread	-0.0018**	-0.18	0.0027**	0.27				
	(-2.96)		(3.23)					
Turnover							0.0004	0.04
							(1.43)	

Table V

Persistence of Market-to-Book Effects

The sample is selected from annual COMPUSTAT data in a manner consistent with Baker and Wurgler (2002). Specifically, we start with all non-financial, non-utility firms listed on COMPUSTAT prior to 2000 and drop firms with missing values for Book Assets or with a minimum value for Book Assets of less than $10 million. Panel A presents our replication of Baker and Wurgler's (2002) result ("All Firms" row of Panel A in Table III), which is a Fama-MacBeth regression in which a cross sectional regression is run each year from 1980 through 1999 of Book Leverage in year t on the year t-1 values of the following variables: MA/BA, defined as the ratio of total assets minus book equity plus market equity to total assets; EFWA, defined as the weighted average of MA/BA from the first year Compustat reports market value data for that firm through year t-1, where the weights are the proportion of the firm's total external finance (net equity issued plus net debt issued) raised in each year; PPE/A, defined as net property plant and equipment divided by assets; EBITDA/A, defined as earnings before interest, taxes and depreciation divided by assets; and Size, defined as the log of net sales. Reported coefficients are the time series average of the estimated cross-sectional coefficients. Panel B presents the results from running the same regression on subsamples determined by adjustment cost proxies: estimated underwriter spread, Altman's Z-Score, and debt credit rating. Since the other coefficients are largely unaffected and our focus is on the impact of adjustment costs on the EFWA parameter, the other coefficients and t-stats are suppressed. For the first two proxies, the portfolios are formed using the lower, middle, and upper third of the proxy distribution. For the credit rating proxy, we form the portfolio based on an above or below investment grade credit rating.

Panel A: Replication of Baker and Wurgler (2002) Results

	Intercept		EFWA		MA/BA		PPE/A		EBITDA/A		Size		
	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t	r^2
Full Sample	48.99	36.31	-8.07	-20.96	3.19	4.19	0.03	3.02	-0.58	-10.06	2.64	11.94	0.22

Panel B: Portfolios by Adjustment Costs

		EFWA	
Cost Proxy		Coeff	t
Estimated Spreads	Low Cost	-5.18	-13.20
	Med Cost	-7.42	-12.97
	High Cost	-10.04	-16.18
Z-score	Low Cost	-5.64	-10.15
	Med Cost	-8.94	-17.75
	High Cost	-8.15	-6.54
Credit Rating	Low Cost	-6.39	-16.34
	High Cost	-9.32	-7.17

Table VI

The Effect of Market Timing on Financing Decisions

The sample consists of quarterly COMPUSTAT data from 1984 to 2001 and is restricted to firms with at least four years of contiguous data and no missing values for equity issuances, equity repurchases, long term debt, short term debt or book assets. Financial firms (SICs 6000-6999) and utilities (SICs 4900-4999) are excluded. All variables are normalized by total assets and measured at time $t-1$ unless otherwise noted. *Equity Return* is the cumulative four-quarter stock return. Δ*Leverage* is the change in leverage. *Leverage* is the ratio of total debt to the sum of total debt and the market value of equity. *StockIss* is a binary variable equal to one for the period after a stock issuance event occurs during a spell. *EFWA* is the external finance weighted average market-to-book ratio, defined as in Baker and Wurgler (2002). The following variables are not presented in the table, but are included in the model. *Size* is the ratio of sales for firm i in quarter t to the sum of sales for all firms in quarter t. *MA/BA* is the ratio of total assets minus book equity plus market equity to total assets. *CapEx (t+1)* is capital expenditures in quarter $t+1$. *Cash* is cash and short-term marketable securities. *DepAmort* is depreciation and amortization. *Tangibility* is the value of tangible assets. *Profitability* is net operating income. *Volatility* is the absolute value of the change in net income. *Z-Score* is the sum of 3.3. times earnings before interest and taxes plus sales plus 1.4 times retained earnings plus 1.2 times working capital, all divided by total assets. *Selling Expense* is selling expenses as a fraction of sales. Binary variables corresponding to years, quarters and 2-digit SIC codes are also included. *Estimated Spreads*, appearing only in the debt issuance model, represents the estimated underwriter spread for the issuance that ends each spell, calculated using estimated equations for debt and equity issuance spreads from Altinkilic and Hansen (2000). For right censored spells, this is replaced by the estimated spread for the issuance or repurchase that ended the previous spell. The hazard impact (*HI*) is defined as: $100 \times (\exp\{\beta\} - 1)$, where β is the estimated coefficient, and measures the percentage shift in the hazard curve due to a 1-unit change in the covariate. t-statistics are presented in parentheses below the corresponding estimate. Statistical significance at the 1% (5%) level is indicated by two (one) asterisks.

	Debt Issuance				Leverage Increase			
	(1)		(2)		(3)		(2)	
Coefficient	Estimate	HI	Estimate	HI	Estimate	HI	Estimate	HI
Δ Leverage	-0.0081**	-0.81	-0.004*	-0.40	-0.0096**	-0.95	-0.0052**	-0.52
	(-4.16)		(-2.05)		(-4.97)		(-2.68)	
Leverage	-0.0093**	-0.92	-0.008**	-0.80	-0.0088**	-0.87	-0.0078**	-0.78
	(-10.11)		(-8.83)		(-9.77)		(-8.83)	
StockIss	0.0778	8.09			0.0707	7.33		
	(1.80)				(1.59)			
LeverDown			0.3647**	44.01			0.3821**	46.53
			(11.31)				(11.88)	
EFWA			-0.0049	-0.49			-0.0205	-2.03
			(-0.21)				(-0.93)	

Table VII

The Impact of Stock Returns on Leverage

One hundred annual debt and equity values are simulated from the model in Fischer et al. (1989) using the following parameter values: corporate tax rate of 50%, personal tax rate of 35%, asset value variance of 5%, net debt issuance transaction cost of 1%, riskless interest rate of 2%, and bankruptcy costs of 20% of asset value. The following OLS regression, as specified by Welch (2004), is then run:

$$\frac{D_{t+k}}{D_{t+k}+E_{t+k}} = \alpha_0 + \alpha_1 \cdot \frac{D_t}{D_t+E_t} + \alpha_2 \cdot \frac{D_t}{D_t+E_t \cdot (1+r_{t,t+k})} + \varepsilon_t,$$

where $r_{t,t+k} = (E_{t+k} - E_t)/E_t$ is the equity price appreciation. The simulation and regression procedures are repeated 500 times, producing a series of parameter estimates $(\alpha_0, \alpha_1, \alpha_2)$ and R-squareds. The table below presents the means of the parameters and R-squareds. Also presented is a reproduction of the results from Panel B of Table 3 in Welch (2004).

	Simulated Data Results				Welch (2004) Results			
Horizon (k)	α_0	α_1	α_2	R^2	α_0	α_1	α_2	R^2
1-year	0.05	-0.26	1.11	0.52	0.03	-0.05	1.02	0.91
3-year	0.16	-0.21	0.66	0.32	0.07	-0.04	0.94	0.78
5-year	0.19	-0.18	0.49	0.23	0.09	-0.01	0.87	0.70
10-year	0.22	-0.12	0.33	0.15	0.14	0.07	0.71	0.56

Figure 1

Simulated Leverage Dynamics Under Different Adjustment Cost Regimes

The figure presents simulated data under three different adjustment cost scenarios: fixed (Panel A), proportional (Panel B), and fixed plus (weakly) convex (Panel C). The simulations are implemented assuming that leverage follows a random walk in the no-recapitalization region, defined by the lower ($\underline{L}$) and upper ($\bar{L}$) boundaries, which are chosen to be one standard deviation from the initial leverage. The optimal recapitalization policy is determined by the assumed form of adjustment cost. The circles correspond to periods of recapitalization. In Panel A, the dotted line (L^*) represents the (optimal) initial value to which firms recapitalize after hitting either the upper or lower boundary. In Panel C, the dotted lines, $\bar{L}^*$ and $\underline{L}^*$, correspond to the optimal leverage after recapitalizations resulting from hitting the upper and lower boundary, respectively.

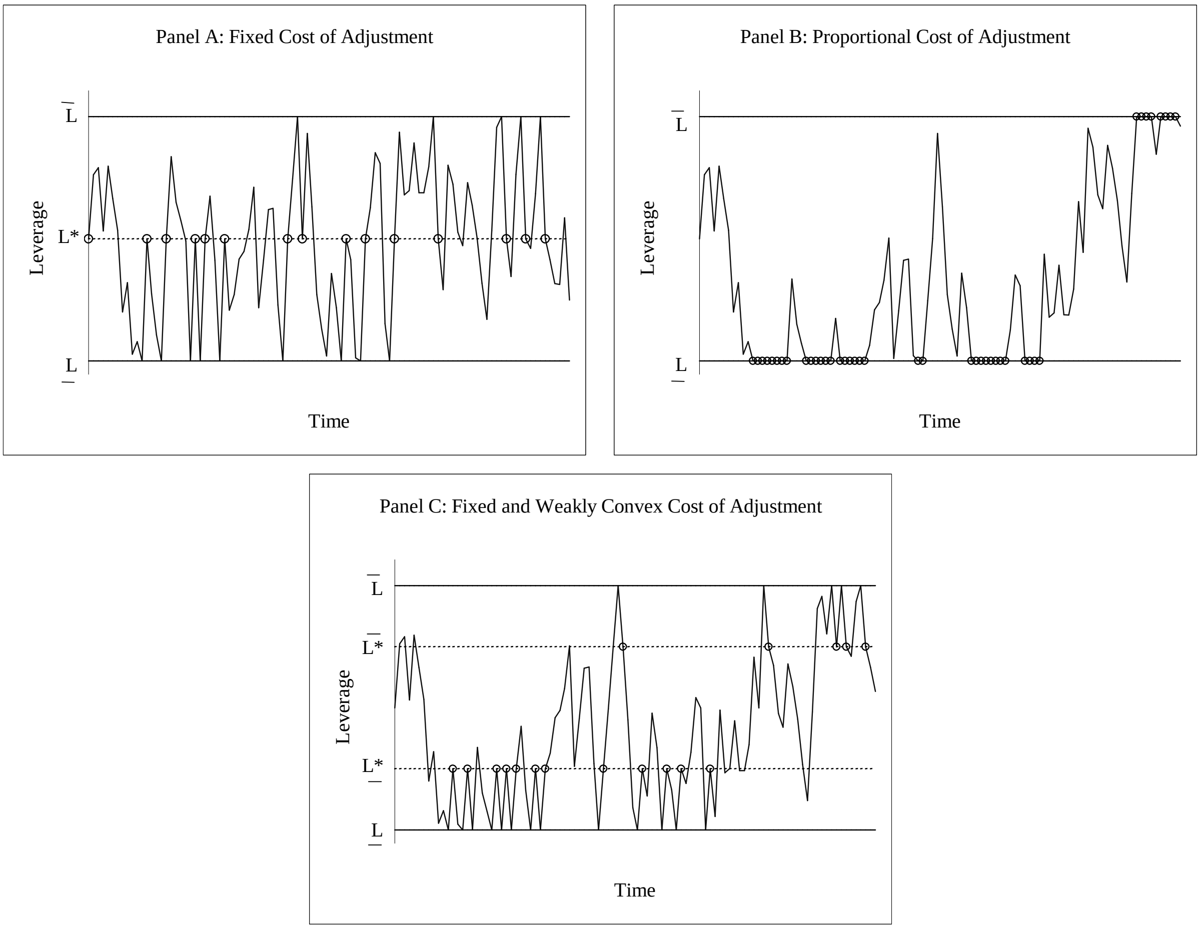


Figure 2

Simulated Hazard Curves Under Different Adjustment Cost Regimes

The figure presents hazard curves estimated from simulated data under three different adjustment cost regimes: fixed (Panel A), proportional (Panel B), and fixed plus (weakly) convex (Panel C). The simulations are implemented assuming that leverage follows a random walk in the no recapitalization region and that the optimal control policy is undertaken at each recapitalization point (see Figure I for an illustration of the resulting leverage dynamics). For each cost regime, 100 paths of 100 observations are simulated. The hazard curve for leverage increasing adjustments is then parameterized as a cubic polynomial and estimated via maximum likelihood, assuming that the durations are independent and exponentially distributed. Estimated hazard curves for leverage decreasing adjustmentes yield similar results.

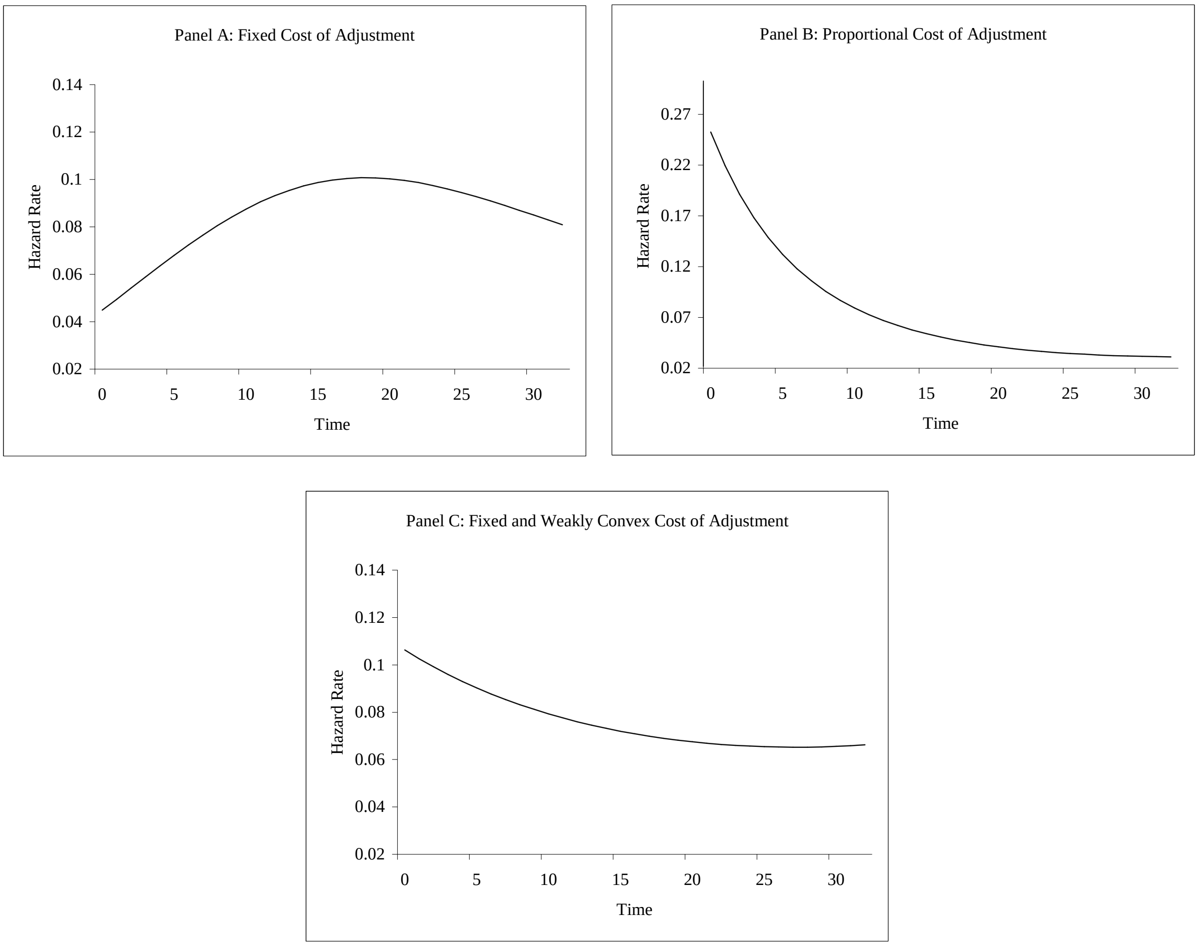


Figure 3
Estimated Hazard Curves

The sample consists of quarterly COMPUSTAT data from 1984 to 2001 and is restricted to firms with at least four years of contiguous data and no missing values for equity issuances, equity repurchases, long term debt, short term debt or book assets. Financial firms (SICs 6000-6999) and utilities (SICs 4900-4999) are excluded. The four basic financing spikes (Debt Issue, Debt Retirement, Equity Issue, Equity Repurchase) are defined as a net security issuance or repurchase of at least 5% of book assets. The two leverage adjustments (Leverage Increase and Leverage Decrease) are defined as a difference in net debt issued and net equity issued that is greater in magnitude than 5% of book assets. The figures present estimates of the baseline hazard curve. The jagged curve presents the step function estimate. The smooth curve presents the cubic polynomial estimate, the parameters and t-stats of which are presented in the accompanying boxes.

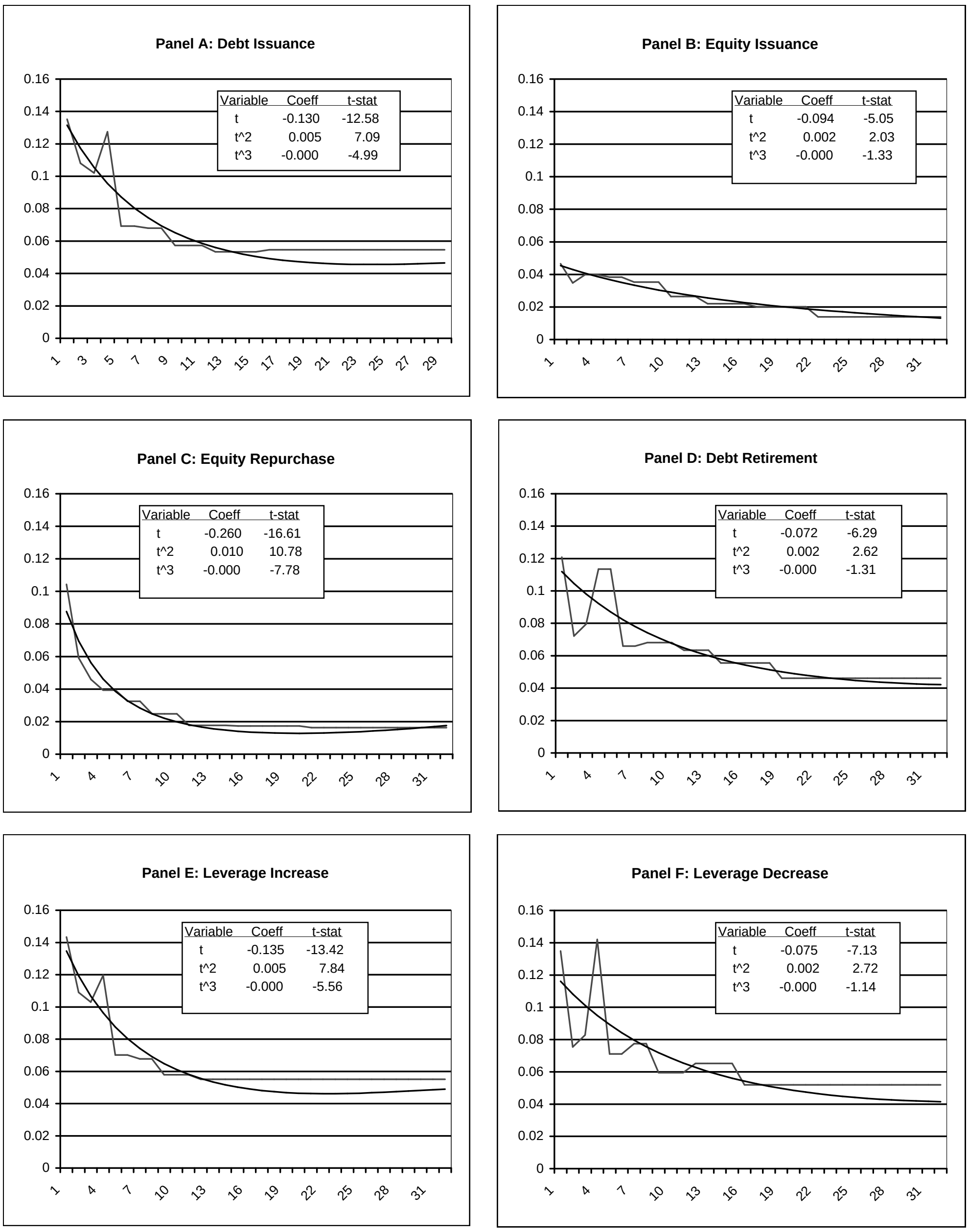
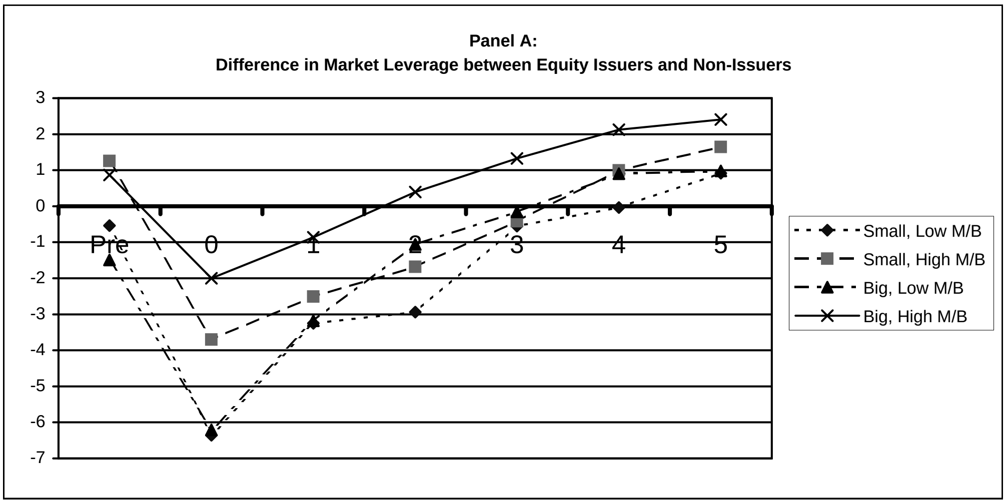


Figure 4

Response to Equity Issuances

The sample is selected from annual COMPUSTAT data in a manner consistent with Baker and Wurgler (2002). Specifically, we start with all non-financial, non-utility firms listed on COMPUSTAT prior to 2000 and drop firms with missing values for book assets or with a minimum value for book assets of less than $10 million. Each year, the entire sample is stratified into four portfolios based on the median asset size (big and small) and median market-to-book ratio (high and low) of the firm. Within each of these portfolios, the sample is split between those firms that issued equity and those that did not. Holding the firms in these portfolios constant, we track the average difference between the market leverage of the issuers and non-issuers over the next five years. To clarify, in 1990, for example, we form four size/market-to-book portfolios based on firm characteristics at the end of 1989 and compute the average difference in leverage between those firms that issued equity in 1990 and those that did not within each of the four portfolios. We then follow these same portfolios of firms over the next five years (and previous year), recomputing the difference in the leverage at each point in time. We repeat this exercise for each year from 1975 through 1995 and then average across event times (i.e. start of the issue period, end of the issue period, one year after the issue period, etc.). These results are presented in Panel A. Panel B presents the difference of the fraction of firms among the equity issuers and non-issuers that subsequently issue debt.



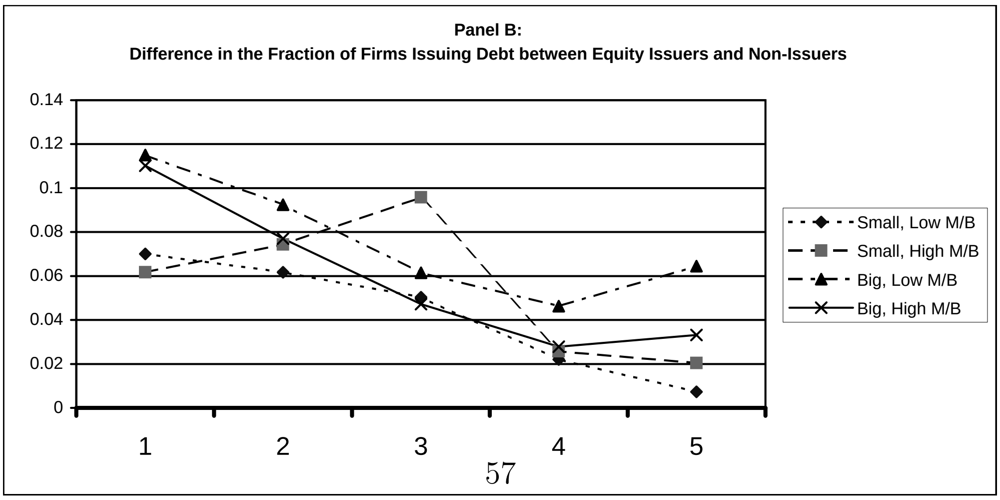
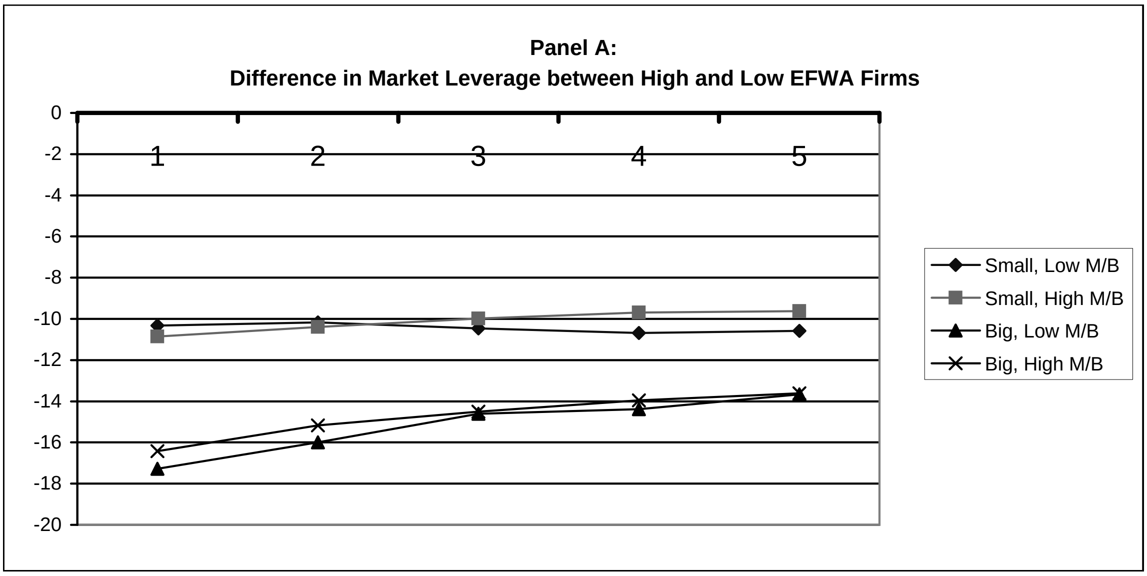


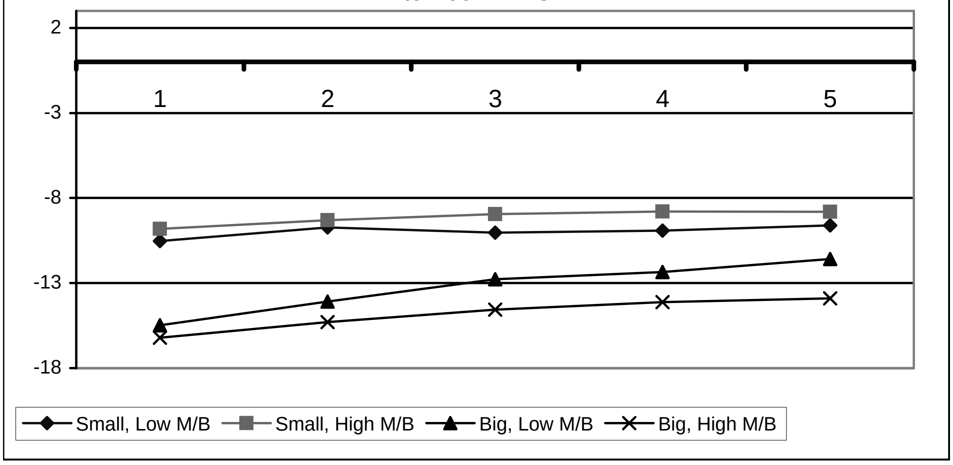
Figure 5

The Leverage of High and Low EFWA Firms

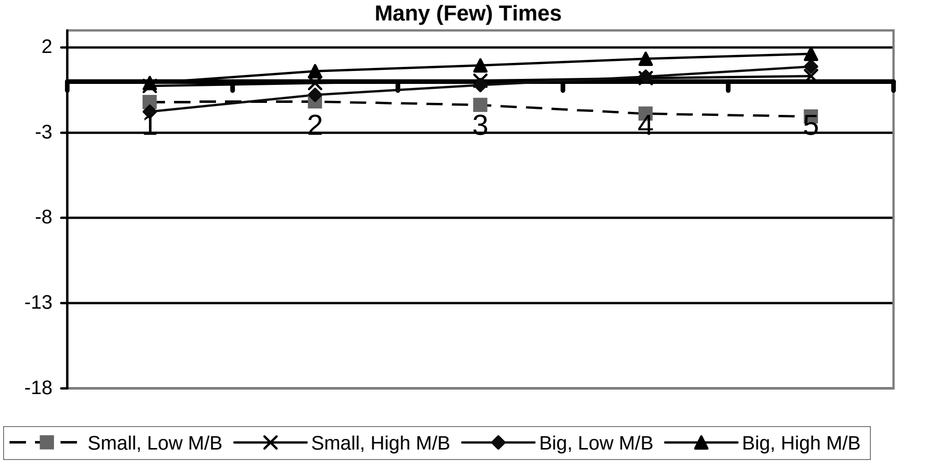
The sample is selected from annual COMPUSTAT data in a manner consistent with Baker and Wurgler (2002). Specifically, we start with all non-financial, non-utility firms listed on COMPUSTAT prior to 2000 and drop firms with missing values for Book Assets or with a minimum value for Book Assets of less than $10 million. Each year, the entire sample is stratified into four portfolios based on the median asset size of the firm (big and small) and the median market-to-book ratio of the firm (high and low). Within each of these four portfolios, the sample is split between those firms with a high and low (above and below median) lagged value for Baker and Wurgler's (2002) external finance weighted average market-to-book (EFWA). Holding firms in the four size/market-to-book portfolios constant, we track the average difference between the market leverage of these two groups within each of the four portfolios over the next four years. To clarify, in 1990, for example, we form four size/market-to-book portfolios based on firm characteristics at the end of 1989 and compute the average difference in leverage between the high and low EFWA firms in each of the four portfolios. We then follow these same portfolios of firms over the next four years, recomputing the difference in the leverage at each point in time. We repeat this exercise for each year from 1975 through 1995 and then average across event times. These results are presented in Panel A. Panels B, C and D replicate the analysis of Panel A, only comparing the leverage of groups distinguished by the average of their historical market-to-book values (high versus low), the number of times per year they have issued equity in the past (many versus few), and the average size of past equity issuances relative to book assets (large versus small). We use medians to distinguish between groups within each portfolio.



Panel B:
Difference in Market Leverage between High and Low Average Market-to-Book Firms



Panel C:
Difference in Market Leverage between Firms that have Issued Equity Many (Few) Times



Panel D:
Difference in Market Leverage between Firms Issuing Large (Small) Amounts of Equity

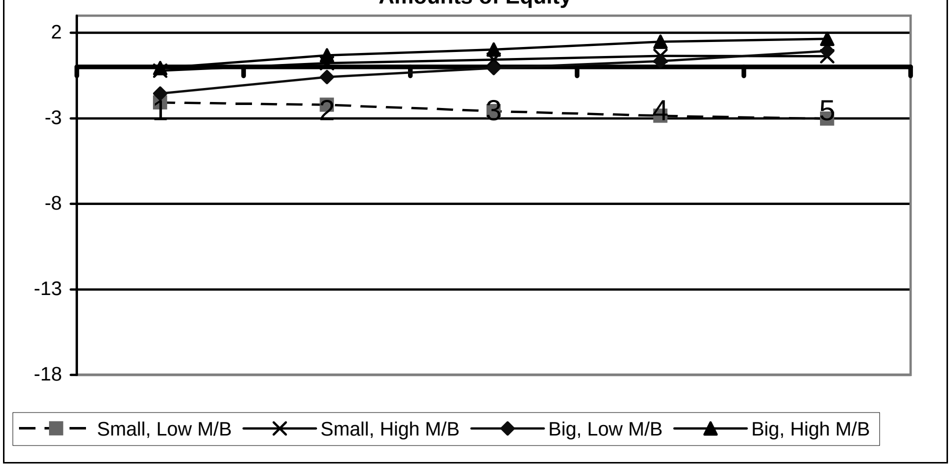
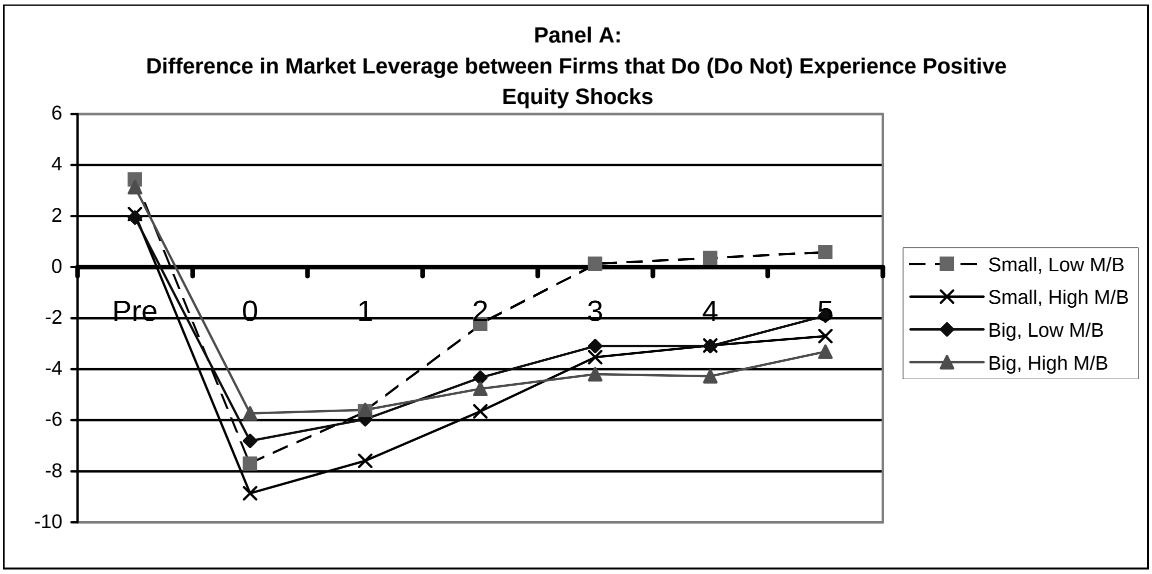
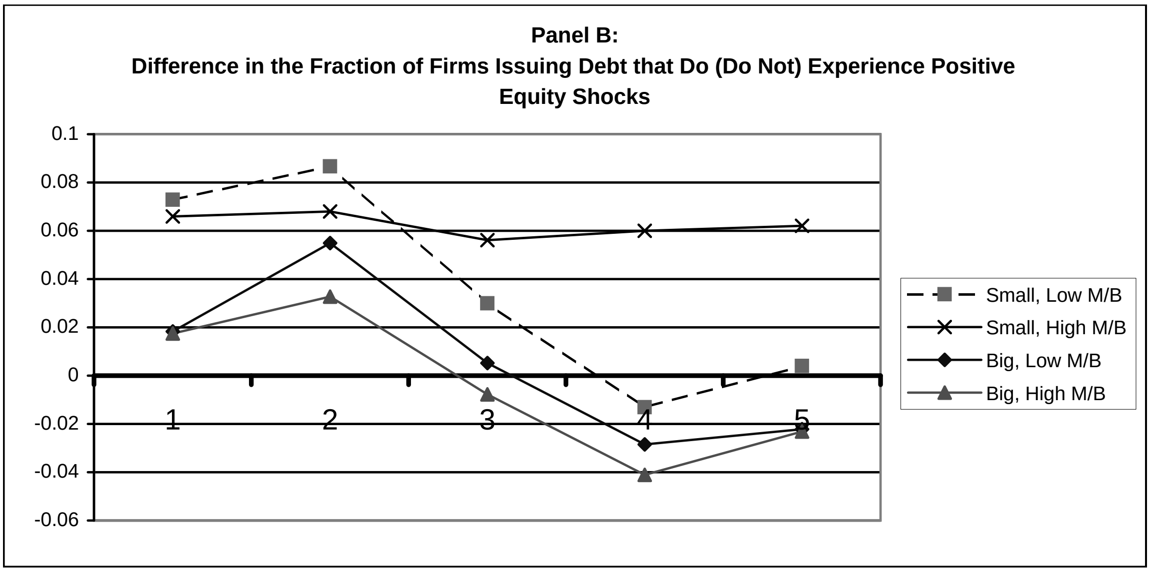
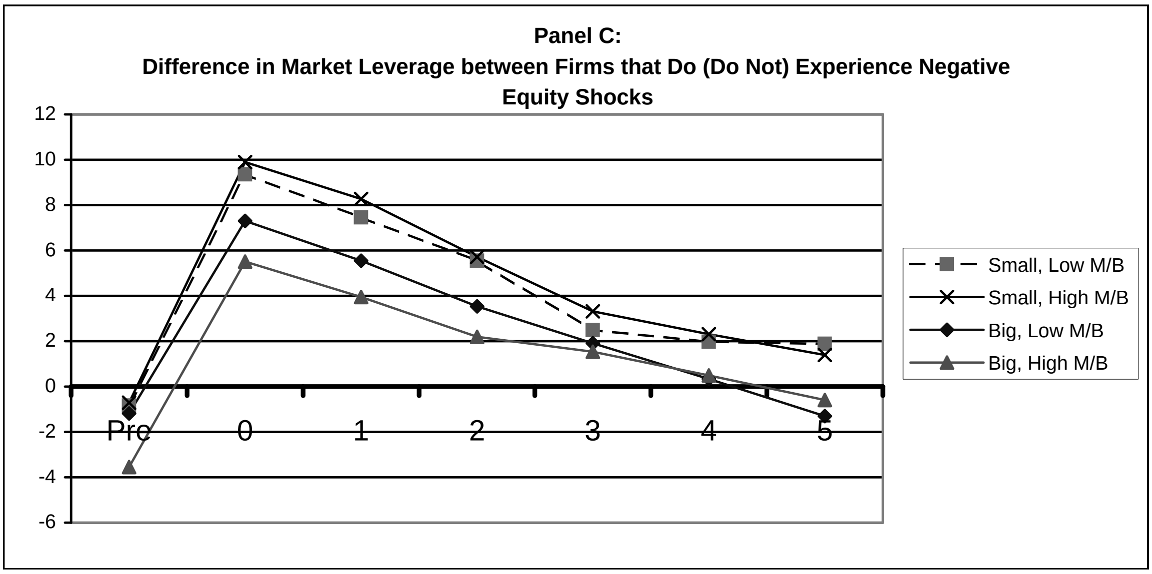


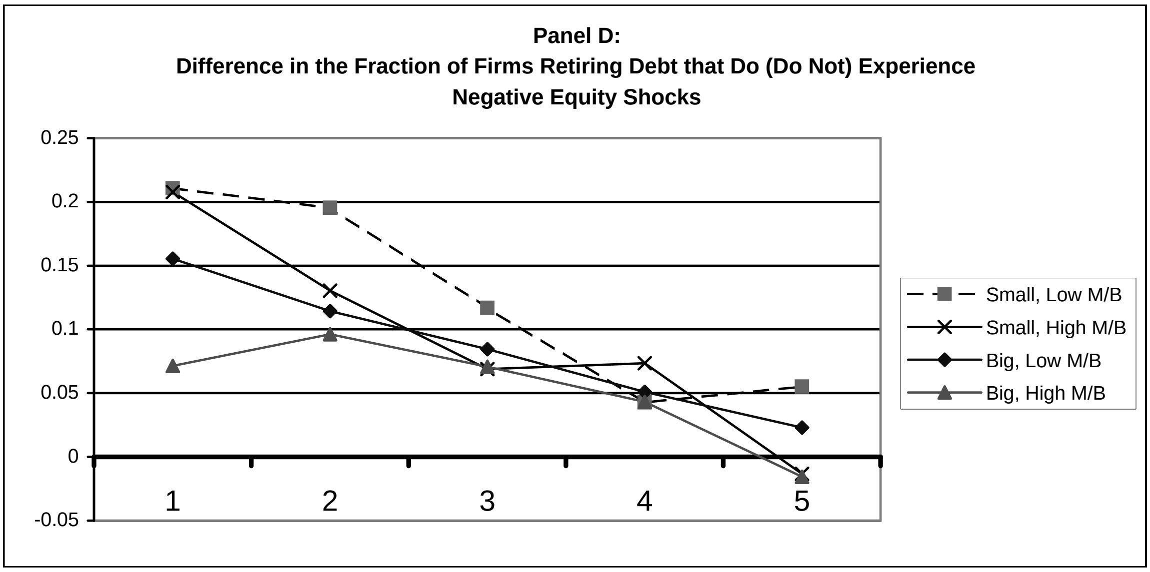
Figure 6
Response to Equity Shocks

The sample is selected from annual COMPUSTAT data in a manner consistent with Welch (2004). Specifically, we start with all non-financial, non-utility firms listed on both COMPUSTAT and CRSP from 1962 to 2000 and exclude those firm-years for which the market value of equity at the beginning of the year is less than the level of the S&P 500 Index divided by 10 (in $ millions). Each year, the entire sample is stratified into four portfolios based on the median asset size (big and small) and median market-to-book ratio (high and low) of the firm. Within each of these portfolios, the sample is split between those firms that experience a positive (negative) equity shock and those that did not, where a shock is defined as an equity return at least one standard deviation above (below) the firm-specific mean. Holding the firms in these portfolios constant, we track the average difference between the market leverage of these two groups within each of the four portfolios over the next five years (and previous year). To clarify, in 1990, for example, we form four size/market-to-book portfolios based on firm characteristics at the end of 1989 and compute the average difference in leverage between firms that experience a positive (negative) shock in 1990 and those that did not in each of the four portfolios. We then follow these same portfolios of firms over the next five years (and previous year), recomputing the difference in the leverage at each point in time. We repeat this exercise for each year from 1975 through 1995 and then average across event times (i.e. year prior to shock, year of the shock, one year after the shock, etc.). The results for positive (negative) shocks are presented in Panel A (C). Panel B presents the difference in the fraction of firms that do (do not) experience a positive equity shock and subsequently issue debt. Panel D presents the difference in the fraction of firms that do (do not) experience a negative equity shock and that subsequently retire debt.


Panel A:
Difference in Market Leverage between Firms that Do (Do Not) Experience Positive Equity Shocks
6
4
2
0
-2
-4
-6
-8
-10
Pre
0
1
2
3
4
5
Small, Low M/B
Small, High M/B
Big, Low M/B
Big, High M/B


Panel B:
Difference in the Fraction of Firms Issuing Debt that Do (Do Not) Experience Positive Equity Shocks
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
1
2
3
4
5
Small, Low M/B
Small, High M/B
Big, Low M/B
Big, High M/B


Panel C:
Difference in Market Leverage between Firms that Do (Do Not) Experience Negative Equity Shocks
12
10
8
6
4
2
0
-2
-4
-6
Pre
0
1
2
3
4
5
Small, Low M/B
Small, High M/B
Big, Low M/B
Big, High M/B


Panel D:
Difference in the Fraction of Firms Retiring Debt that Do (Do Not) Experience Negative Equity Shocks
0.25
0.2
0.15
0.1
0.05
0
-0.05
1
2
3
4
5
Small, Low M/B
Small, High M/B
Big, Low M/B
Big, High M/B