Asymmetric Capital Structure Adjustments: New Evidence from Dynamic Panel Threshold Models

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April 2008

Abstract

This paper proposes a novel empirical approach, called dynamic threshold models of leverage, to testing the dynamic trade-off theory, allowing for costly and asymmetric capital structure adjustments. The framework enables us to consistently estimate asymmetric speeds of adjustment in different regimes, each of which is associated with a differential adjustment cost. We examine several variables that proxy for adjustment costs, financial flexibility and financial constraints that affect capital structure adjustment. The empirical results suggest that firms deviating considerably away from the target leverage undertake slower adjustment, low-growth firms adjust more quickly, and internal financial constraints (measured by payout ratios and firm investment) significantly reduce the speed of adjustment. Overall, the paper documents strong evidence in favor of heterogeneous (but relatively fast) speeds of adjustment and asymmetric adjustment paths, a finding consistent with the dynamic trade-off theory of capital structure.

JEL Classification: C12, G32.
Keywords : Capital Structure, Target Leverage, Dynamic Trade-off Theory, Dynamic Threshold Panel Data Model.

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1 Introduction

Since the irrelevance theorem by Modigliani and Miller (1958), three main theories of capital structure have been advanced in which the method of financing matters: the trade-off, pecking order and market-timing theories.[1] The trade-off theory, in both static and dynamic forms, suggests an optimal capital structure that balances between the costs (e.g. bankruptcy costs) and benefits (e.g. interest tax shields) of debt financing, e.g. Hennessy and Whited (2006) and Strebulaev (2007). Under this framework, leverage is predicted to exhibit mean-reversion as the firm seeks to adjust actual leverage toward target leverage. The pecking order theory suggests that the firm's observed level of debt simply reflects cumulative financing decisions, where internal finance is preferred to external finance and debt is preferred to equity (Myers, 1984; Myers and Majluf, 1984). The market timing theory posits that capital structure decisions are driven by market timing considerations in which the firm attempts to time the capital market by issuing equity when the market condition is favorable, e.g. Baker and Wurgler (2002).[2] An important feature of both the pecking-order and market timing theories is that they do not envisage the existence of target leverage and the firm's adjustment toward the target leverage. Therefore, a number of empirical studies have attempted to examine the validity of trade-off theory against alternative theories by testing whether adjustment toward target leverage takes place.

The major body of recent empirical research on capital structure has documented evidence in favor of (mean-reverting) adjustment toward target leverage, a finding consistent with the trade-off theory.[3] Ozkan (2001) and Flannery and Rangan (2006) estimate a partial adjustment model of leverage and find that both the U.K. and the U.S. firms undertake adjustment toward target leverage reasonably quickly with more than one third of the deviation from the target being closed per year. Antoniou et al. (2007) estimate a similar model and document evidence for a quick speed of adjustment for a large panel of firms operating in both capital market-oriented economies (the U.K. and the U.S.) and bank-oriented economies (France, Germany and Japan). However, an important limitation of these studies is the assumption that firms adjust leverage toward target leverage in a symmetric manner in which the speed of adjustment is homogenous for all firms. Importantly, the popular partial adjustment approach fails to capture the main idea behind the dynamic trade-off framework (Fischer et al., 1989; Leary and Roberts, 2005), in which firms facing differential adjustment costs may take different adjustment paths so that the speed of adjustment for different groups of firms becomes heterogeneous.

This paper aims to fill this gap and develops a novel empirical model that explicitly allows for costly adjustment of leverage and tests the dynamic trade-off theory of capital structure. In particular, we propose a dynamic panel threshold model of leverage that embeds a partial linear adjustment model. It enables one to estimate heterogeneous adjustment speeds in different 'refinancing regimes', each of which is associated with a differential capital structure adjustment cost. To illustrate its advantage, consider a dynamic setting in which a firm faces differential adjustment costs when changing its capital structure. Rather than having a unique target leverage ratio, the firm will consider a target range within which it allows leverage ratio to vary. Capital structure adjustments are undertaken only when the

[1] See Frank and Goyal (2005) for a survey on recent developments.

[2] See also Welch (2004) who finds some evidence for the inertia theory's prediction that capital structure is determined by movements of stock returns.

[3] Jalilvand and Harris (1984) and Auerbach (1985) provide earlier evidence for mean reversion of leverage.

costs of adjustment are outweighed by the benefits of being close to the target. The speed and magnitude of adjustment are then dependent on the deviation of the actual leverage from the target, i.e., the regime into which the firm is classified. Under this framework, the conventional partial adjustment model assuming a homogenous speed of adjustment becomes inappropriate. The two-regime dynamic threshold model proposed in this paper allows us to estimate heterogeneous speeds of adjustment in the low and high regimes that are determined by the (estimated) threshold value of leverage deviation, for example, where leverage deviation is used as the transition variable determining the regime status of the firm.[4]

The paper contributes to the empirical literature on the dynamic trade-off theory of capital structure as follows: First, this is the first paper that develops a dynamic regime-switching model of leverage that is capable of directly testing the validity of the dynamic trade-off theory. Recent empirical studies have attempted to model costly adjustment or investigate factors affecting the speed of adjustment, e.g. Flannery and Hankins (2007). Alternatively, Leary and Roberts (2005) examine the implications of costly adjustment on dynamic financing decisions using non-parametric and duration analyses, and document active rebalancing of leverage, which provides a partial support for the dynamic trade-off theory advanced by Fischer et al. (1989).[5] Dudley (2007) develops an empirical framework for estimating the lower and the upper bounds of the target leverage range. Our paper is also related to another line of research that investigates the relationship between the adjustment speed and various firm-specific and macroeconomic variables, e.g. Drobetz and Wanzenried (2006) and Drobetz et al. (2006), though their approach does not address the issue as how to estimate the (heterogeneous) speed of adjustment directly. We focus on consistently estimating heterogeneous adjustment speeds at which firms adjust leverage toward the target leverage. We also provide further insights into the characteristics of firms that have differential adjustment costs and consequently differential capital structure adjustment paths.

The second contribution is a methodological one. We advance new econometric techniques that will provide both consistent and efficient estimates of the speeds of adjustment in an asymmetric dynamic panel data model with unobserved individual effects and short time periods. In order to examine the trade-off behavior for firms with different characteristics, most recent studies adopt the simple sample-splitting or dummy variable approach, e.g. Byoun (2007), Faulkender et al. (2007) and Flannery and Hankins (2007). This approach may be useful under strong assumptions, though the way the sample is split is at most arbitrary and is likely to result in a sample selection problem. The threshold model developed in this paper overcomes this problem, and specifically our proposed estimation procedure combines time series techniques on nonlinear threshold modeling (e.g. Hansen, 1999) and the existing estimation techniques for dynamic panels (see Alvarez and Arellano, 2003 for a review). It involves utilizing and generalizing the Anderson and Hsiao (1982) instrumental variable estimator (hereafter AH-IV), the Arellano and Bond (1991) generalized methods of moments estimator (hereafter GMM) and Blundell and Bond (1998) system GMM estimators (hereafter SYSGMM) to a new estimation approach applicable for dynamic threshold panel models. See Shin (2007) for details.

Using an unbalanced panel of the U.K. firms over the period 1998-2003, we document

[4] The paper also considers a number of other factors such as the firm's financial flexibility, internal and external financial constraints as potential determinants of the speed of adjustment.

[5] Notice however that this finding is also argued to be in line with the modified pecking order theory.

a fast speed of capital structure adjustment. More importantly, there is strong evidence in favor of asymmetries in capital structure adjustment; namely, the adjustment speeds are heterogeneous for firms facing differential adjustment costs, a finding consistent with the dynamic trade-off framework. Our main results are summarized as follows. First, firms with a large deviation (ratio) from the target leverage undertake slow adjustment toward the target, a finding in line with the argument that firms deviating considerably far away from the target leverage face high adjustment costs. Second, profitable firms have a slow speed of adjustment, a finding inconsistent with the prediction that firms with available internal funds and financial flexibility can undertake internal adjustment more quickly. Third, internal financial constraints, as measured by dividend payout ratio and firm investment, significantly reduce the speed of adjustment. Fourth, low-growth firms adjust leverage more quickly than high-growth firms. Firms with low growth options are found to possess the characteristics of 'quality' firms, implying that they have an easier access to the capital market but also high leverage and potentially high liquidation costs, resulting in a faster speed of adjustment. The evidence on external financial constraints, as measured by firm size and stock price movements is inconclusive. Throughout the analysis, we consistently observe a positive relationship between leverage and the speed of adjustment; namely, firms adjusting toward target leverage quickly are generally highly leveraged. This makes a general statement that highly leveraged firms may face potentially high bankruptcy and liquidation costs, which force them to undertake quicker capital structure adjustment.

The remainder of the paper is organized as follows. Section 2 provides an overview of the conventional testing framework for the static trade-off theory and then develops a threshold partial adjustment model of leverage. Section 3 discusses the potential variables affecting the speed of adjustment, which will be employed as the transition variable under the regime-switching framework. Section 4 develops the estimation and testing procedure for the dynamic threshold panel data model, and discusses the data characteristics. Section 5 reports and discusses the empirical results. Section 6 concludes.

2 Capital Structure Adjustment Models

2.1 Static Trade-off Model with Homogenous Adjustment Speed

The conventional econometric specification to model adjustment toward target leverage predicted by the static trade-off theory takes the form of a partial adjustment process (e.g. Ozkan, 2001; Fama and French, 2002; Flannery and Rangan, 2006):

$$\Delta\ell_{it} = \delta\left(\ell^*_{it} - \ell_{it-1}\right) + v_{it}, \tag{1}$$

where ℓ_{it} and ℓ^*_{it} denote the actual (observed) and target leverage ratios for firm i at time t, respectively and v_{it} is the (idiosyncratic) error term with zero mean and constant variance. δ is the speed of adjustment, which measures how fast the firm adjusts to target leverage after a shock that sees a deviation. Due to adjustment costs, δ is expected to lie between 0 and 1, with higher δ indicating a faster speed of adjustment.[6][7]

[6]If the firm could adjust to target leverage in one period, the coefficient would be equal to 1.

[7]See also Huang and Ritter (2008) for an alternative partial adjustment model that utilizes ℓ_{it-k} instead of ℓ_{it-1}.

In estimating (1) one problem arises as target leverage is unobservable. Two approaches are available. First, the target leverage can be proxied by the historical mean or the moving average of observed leverage. The drawback of this approach lies in that it is difficult to justify why the target leverage ratio should remain constant over a period of time, e.g. Shyam-Sunder and Myers (1999).

Second, the target leverage can be viewed as a unique ratio determined by the firm individual characteristics.[8] The econometric specification of target leverage is then given by:

$$\ell_{it}^{*} = \beta' x_{it} + u_{it} \tag{2}$$

where x_{it} denotes the $k \times 1$ vector of exogenous or predetermined factors and β the associated structural parameters and u_{it} is the error term with zero mean and constant variance. In estimating (2) together with (1), there are two approaches available. The first is a two-stage procedure proposed by Shyam-Sunder and Myers (1999) and Fama and French (2002), in which one regresses actual leverage on the control variables in (2) and obtain the fitted values $\hat{\ell}_{it}^{*} = \hat{\beta}' x_{it}$, with $\hat{\beta}$ being the consistent estimator of β, which will be used as a proxy for the target leverage in (1). The alternative is a one-step procedure (Ozkan, 2001; Flannery and Rangan, 2006), in which (2) is substituted into (1) to yield:

$$\ell_{it} = \phi \ell_{it-1} + \pi' x_{it} + u_{it}, \tag{3}$$

where $\phi = 1 - \delta$, $\pi = \delta\beta$, and $\epsilon_{it} = \nu_{it} + \delta u_{it}$.

2.2 Dynamic Trade-off Model with Heterogeneous Adjustment Speeds

Estimation of static trade-off models implicitly assumes that adjustment takes place continuously in a symmetrical fashion. In the presence of costly adjustment, this assumption is no longer valid because capital structure adjusts infrequently at 'restructuring points' as highlighted by Fischer et al. (1989) and Leary and Roberts (2005). Firms may allow actual leverage to deviate from target leverage as long as adjustment costs outweigh the benefits of rebalancing. Alternatively, firms may take different adjustment paths according to their financial position of the actual leverage relative to the target.

To capture this dynamic trade-off behavior, we develop a non-linear regime-switching model that allows the speed of adjustment to vary in different regimes. The model specification is as follows:

$$\Delta \ell_{it} = \delta_1 \left(\ell_{it}^{*} - \ell_{it-1} \right) 1_{\{q_{it} \le c\}} + \delta_2 \left(\ell_{it}^{*} - \ell_{it-1} \right) 1_{\{q_{it} > c\}} + v_{it}, \tag{4}$$

where $1\{\cdot\}$ is an indicator function taking unity if the event is true and 0 otherwise. q_{it}, is the (regime-switching) transition variable and c the threshold parameter. The parameters, δ_1 and δ_2, stand for heterogeneous adjustment speeds associated with different regimes.

Model (4) represents an important extension of the (symmetric) partial adjustment model, (1), in that it allows for heterogeneous adjustment paths of leverage across different

[8] In order to facilitate comparisons with previous research, five determinants of leverage including collateral value of assets (tangibility), non-debt tax shields, profitability, growth opportunities and firm size are considered. For a comprehensive list of the potential determinants of leverage, see Harris and Raviv (1991) and Frank and Goyal (2005). Also see Table 1 for definitions of the control variables used.

regimes, which are determined by the transition variable, q_{it}, and the threshold c. To further illustrate the advantages of this model, we revisit the example presented in the Introduction where the transition variable is the absolute deviation of observed (actual) leverage from the (estimated) target leverage. Model (4) enables us to estimate of the speed of adjustment for firms in each regime, depending on the (relative) size of the deviation from target leverage. The dynamic trade-off framework developed by Fischer et al. (1989) suggests there is a target leverage range within which firm makes infrequent capital structure adjustment because adjustment costs may outweigh the benefits of reaching the target leverage ratio. Further, in the presence of fixed adjustment costs, the larger the deviation from target leverage, the higher the costs of having a suboptimal capital structure. Capital structure adjustment takes place frequently at the lower or upper boundaries, at which the benefits of being close to the target leverage ratio outweigh the fixed cost of adjustment. This implies that the higher the absolute deviation from target leverage, the faster the speed of adjustment. However, a conflicting prediction may obtain if one assumes that adjustment costs are an increasing function of the deviation. Firms with actual leverage deviating far away from target leverage may find it too costly to revert back to an optimal capital structure so that adjustment takes place more slowly with a large deviation.

The asymmetric partial adjustment model given by (4) has two methodological advantages over the simple approach that investigates the partial adjustment for firms with different characteristics using sample-splitting or dummy variables e.g. Byoun, 2007. First, the exogenous sample-splitting method requires an arbitrary choice of thresholds, such as the median or quantiles. Our proposed approach overcomes this limitation because it allows the threshold as an unknown parameter to be estimated from the model. Second, unlike the approach using dummies or sub-samples where firms are classified into a regime over the entire sample period, our model allows firms to switch regime over-time depending on the year-to-year proxy for adjustment costs, e.g. the deviation of leverage from target leverage.[9]

3 Determinants of Capital Structure Adjustment Speed

To develop fully the dynamic threshold model introduced in subsection 2.2, we now consider potential regime-switching transition variables. In adjusting leverage toward the target, the firm has a number of rebalancing options. It can issue new debt or repurchase existing shares when the observed leverage is lower than the target leverage; it can issue equity or retire debt when the observed leverage is higher than the target leverage. The firm can also make internal adjustment by keeping profits as retained earnings or pay out as dividends. Moreover, the speed at which the firm adjusts leverage through these alternative financing strategies is determined by capital structure adjustment costs, the firm's financial flexibility, internal and external financial constraints. We next discuss the mechanism in which these factors may affect the speed of capital structure adjustment.

[9] Recent papers have started to employ this switching framework. See Hovakimian and Titman (2007) and Almeida and Campello (2007) for investment models using the endogenous switching framework, which is a related but alternative specification to the threshold model developed in this paper.

3.1 Deviation from Target Leverage and Costly Adjustment

The dynamic trade-off theory suggests that capital structure adjustment does not take place frequently because firms allow leverage to deviate from target leverage as long as adjustment costs (such as transactional and contractual costs) outweigh the benefits of achieving an optimal capital structure, e.g. Fischer et al. (1989). If adjustment costs consist mainly of fixed costs, then the larger the deviation from target leverage, the more likely the firm will undertake adjustment toward the target. There will be some lower or upper bounds where the benefits of achieving the target leverage outweigh the fixed costs of adjustment. At these restructuring points firms should undertake capital structure adjustment more frequently and quickly, implying a positive relationship between the absolute deviation from target leverage and the speed of adjustment.

However, if adjustment costs are an increasing function of the deviation from target leverage, a contrary prediction may obtain, i.e. there may be a negative relationship between the speed of adjustment and the deviation. Firms with actual leverage deviating far away from target leverage may find it too costly to revert back to the target so adjustment takes place slowly and infrequently. Drobetz et al. (2006) argue that when the fixed component of adjustment costs is prohibitively high, firms tend to avoid external adjustment in the form of security issuances/repurchases, and rely more on internal adjustment via payout policies instead. Notice that this strategy may be limited as the scope and the magnitude of internal adjustment are likely to be restricted by the size of internal funds. Furthermore, firms tend to refrain from using all internal funds for adjustment purposes because they may wish to preserve the ability to take future investment opportunities. The small magnitude of internal adjustment may then imply a slower speed of adjustment.

3.2 Internal Financial Constraints

The speed of adjustment is also determined by the firm's financial flexibility, which can be measured by profitability (Flannery and Hankins, 2007). Highly profitable firms have available funds so they do not suffer from severe internal financial constraints while enjoying the financial stability to issue securities at a relatively low cost. In addition, these firms are able to take advantage of debt tax shields and minimize asset substitution effects, especially when they are under-leveraged.[10] The increased financial flexibility and adjustment benefits, therefore, suggest a positive relationship between profitability and the speed of capital structure adjustment.

Dividend payments and firm investment levels can be viewed as alternative measures of internal financial constraints, which, in turn, affect leverage (Lang et al., 1996), as well as adjustment toward target leverage (Flannery and Hankins, 2007). Dividends transfer corporate wealth to shareholders, thereby reducing the retained earnings that are available for capital structure adjustment such as share repurchases or debt retirement. Similarly, high-growth firms with new investments financed with internal funds may become financially constrained when undertaking internal capital structure adjustment. Overall, it is expected that firms with a high payout ratio or a substantial investment set have a high degree of internal financial constraints, implying a slow speed of adjustment.[11]

[10]For under-leveraged firms, retained profits increase the value of equity, resulting in a lower leverage ratio and further deviation from the target. Hence these firms have an incentive to undertake more rapid adjustment.

[11]In the investment literature, however, firms with a low payout ratio are classified as 'financially con-

3.3 Growth Opportunities and External Financial Constraints

The impact of growth opportunities on the speed of adjustment is at best ambiguous. High-growth firms are likely to be young and expected to maintain a low-leverage policy in order to control the under-investment problem (Myers, 1977). They may also have low profitability and limited internal funds so that they are likely to rely more on external (equity) financing to fund growth opportunities. Since these firms raise external finance frequently, it should be easy for them to adjust leverage by appropriately altering the composition of their capital structures, i.e. the choice between debt and equity (Drobetz et al., 2006). In contrast, low-growth firms tend to rely less on external financing and more on internal funds, so any capital structure change is likely to take the form of internal adjustment, the scope and magnitude of which is limited as discussed above. Overall, it is argued that the speed of adjustment is relatively faster for high-growth firms as compared to low-growth firms.

On the other hand, low-growth firms are typically mature, cash-rich and highly profitable companies that should maintain a high-leverage policy according to the free cash flow hypothesis (Jensen, 1986). While these firms do not rely on external financing as much as high-growth firms, they may face less severe asymmetric information and agency problems, making it less costly to adjust their capital structures. Further, low-growth firms with typically high-leverage may find it more beneficial to adjust leverage frequently rather than deviating further away from the target leverage policy so as not to encounter potentially high bankruptcy and liquidation costs.

Capital structure adjustment generally involves substantial transactional costs (e.g. brokerage fees for new issuances) of which the fixed component is relatively smaller (larger) for large (small) firms. Hence, large firms should be able to correct any deviations from target leverage at a relatively lower fixed cost, implying a quicker speed of adjustment (Drobetz et al., 2006). Further, large firms are typically mature and have high tangibility, high profitability, high financial flexibility, low cash flow volatility and low costs associated with financial distress. They also face a less severe asymmetric information, adverse selection and moral hazard problem, and thus have better access to capital markets. Overall, the cost of external financing is smaller for large firms, suggesting a faster speed of capital structure adjustment.

Stock price movements can affect the firm's accessibility to the financial market because they reflect investors' perceptions about the firm's fundamentals and prospects. In particular, increases (decreases) in stock prices may signal a more (less) favorable assessment of the firm, implying a smaller (larger) financing cost and more (less) easy access to additional financing. This suggests that stock price increases allow the firm to undertake capital structure adjustment more easily. Note, however, that stock price decreases may also have a mechanical negative impact on the firm's market value, and consequently, a positive impact on market leverage. For overleveraged firms, this will make them deviate further from the target leverage ratio, thereby affecting the adjustment process (Flannery and Hankins, 2007). Thus it is difficult to envisage the overall impact of stock price movements on the speed of capital structure adjustment.[12]

strained'.

[12] We have also tested alternative measures of external financial constraints such as firm age and debt capacity. Young firms, for example, are typically small and less reputable, thereby facing a high level of asymmetric information and higher cost of external financing. Similarly, firms with a high debt capacity usage may have to borrow additional debt at a higher cost. However, the results for these two measures are inconclusive and therefore unreported.

4 Methodology and Data

4.1 Econometric Methodology

In estimating the dynamic trade-off model, (4), we follow a two-stage procedure; the first step involves estimating the target leverage relationship based on (2), using the pooled OLS or the fixed effects estimators, and obtaining the fitted values as the proxy for target leverage, denoted $\hat{\ell}^*_{it} = \hat{\boldsymbol{\beta}}'\mathbf{x}_{it}$, where $\hat{\boldsymbol{\beta}}$ is the consistent estimate of $\boldsymbol{\beta}$ in (2).

The second step considers consistently estimating the asymmetric partial-adjustment model of the form:

$$\Delta\ell_{it} = \delta_1 \left(\hat{\ell}^*_{it} - \ell_{it-1}\right) 1_{\{q_{it}\leq c\}} + \delta_2 \left(\hat{\ell}^*_{it} - \ell_{it-1}\right) 1_{\{q_{it}>c\}} + v_{it},\ i = 1, ..., N,\ t = 1, ..., T, \quad (5)$$

where ℓ_{it} and $\hat{\ell}^*_{it}$ denote the actual and (estimated) target debt ratios for firm i at time t, $1\{\cdot\}$ is an indicator function, q_{it} is the transition variable with c being a threshold parameter, and δ_1, δ_2 are heterogeneous adjustment parameters associated with different regimes. We assume that the errors, v_{it}, follow the error component specification,[13]

$$v_{it} = \alpha_i + \varepsilon_{it},$$

where α_i is an unobserved individual effect and ε_{it} is a zero mean idiosyncratic random disturbance.

Rewriting (5) for the level of ℓ_{it}, we have:

$$\ell_{it} = \left\{\phi_1\ell_{it-1} + \delta_1\hat{\ell}^*_{it}\right\} 1_{\{q_{it}\leq c\}} + \left\{\phi_2\ell_{it-1} + \delta_2\hat{\ell}^*_{it}\right\} 1_{\{q_{it}>c\}} + v_{it}, \quad (6)$$

where $\phi_i = 1 - \delta_i,\ i = 1, 2$. It is well-established in the linear dynamic panels that the fixed effects estimator of the parameters, (ϕ_1, δ_1) and (ϕ_2, δ_2) in (6), is biased downward in the case where the regressors are correlated with individual effects, e.g. Nickell (1981). Although there is a huge literature on GMM estimation of linear dynamic panels with heterogeneous individual effects, e.g., Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998), and Alvarez and Arellano (2003), there has been no rigorous single study investigating the important issue of nonlinear asymmetric dynamic mechanism in this context.

Recently, Shin (2007) proposes a new estimation procedure to analyze asymmetric threshold effects in dynamic panels with unobserved individual effects when the time period is fixed by combining time series techniques on nonlinear threshold modeling with existing GMM estimation techniques. We adopt this procedure in the context of model, (5).[14] To deal with the correlation of the regressors with individual effects in (5), we consider the following first-difference transformation of (5):

$$\Delta^2\ell_{it} = \delta_1\Delta d_{1it} + \delta_2\Delta d_{2it} + \Delta v_{it},\ i = 1, ..., N,\ t = 2, ..., T, \quad (7)$$

[13] In empirical application we follow the literature and adopt a two-way-error-component model with both fixed firm effects, α_i, and fixed time effects, θ_t, so that so that v_{it} follows the two-way error components: $v_{it} = \alpha_i + \theta_t + \varepsilon_{it}$, e.g. Ozkan (2001). The unobservable firm effects capture the firm and industry characteristics such as managerial ability and skills, level of competition in the industry and life cycle of products. The time effects control for macroeconomic variables, e.g. changes in the state of the economy, interest rates and prices, accounting standards and other regulations.

[14] For the detailed estimation procedure for the general model specification given by (6), see Shin (2007).

where $d_{1it} = \left(\ell_{it}^{*} - \hat{\ell}_{it-1}\right) 1_{\{q_{it} \leq c\}}$, $d_{2it} = \left(\ell_{it}^{*} - \hat{\ell}_{it-1}\right) 1_{\{q_{it} > c\}}$, and $\Delta v_{it} = \Delta\varepsilon_{it}$ that is now free of α_i. The OLS estimator obtained from (7) is still biased since Δd_{1it} and Δd_{2it}, are now correlated with Δv_{it} in (7). To fix this problem, we need to find instruments for Δd_{1it} and Δd_{2it}. The obvious candidates are $d_{1i,t-1}$ and $d_{2i,t-1}$ (e.g. Anderson and Hsiao, 1982), and their lagged values (e.g. Arellano and Bond, 1991).

Exploiting all linear moment conditions, it is straightforward to obtain the following IV matrices for Δd_{1it} and Δd_{2it}, denoted $\mathbf{W}_{1i}^{d}$ and $\mathbf{W}_{2i}^{d}$, respectively for individual $i = 1, ..., N$:

$$\mathbf{W}_{ji}^{d} = \begin{bmatrix} d_{ji2} & 0 & \cdots & 0 \\ 0 & d_{ji2}, d_{ji3} & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & d_{ji2}, ..., d_{ji,T-1} \end{bmatrix}, \ j = 1, 2. \tag{8}$$

We then obtain the $N(T-2) \times 2m_d$ full matrix of instruments with $m_d = 0.5(T-2)(T-1)$:

$$\mathbf{W}_{d} = \begin{bmatrix} \mathbf{W}_{1d} \\ \vdots \\ \mathbf{W}_{Nd} \end{bmatrix}, \ \mathbf{W}_{id} = \left(\mathbf{W}_{1i}^{d}, \mathbf{W}_{2i}^{d}\right), \ i = 1, ..., N. \tag{9}$$

Employing the set of all moment conditions, $E\left(\mathbf{W}_{d}'\Delta\boldsymbol{\varepsilon}\right) = \mathbf{0}$, we obtain the one-step and the two-step GMM estimators by

$$\hat{\boldsymbol{\delta}}_{jd} = \left\{\Delta\mathbf{d}'\mathbf{W}_{d}\mathbf{V}_{jd}^{-1}\mathbf{W}_{d}'\Delta\mathbf{d}\right\}^{-1}\left\{\Delta\mathbf{d}'\mathbf{W}_{d}\mathbf{V}_{jd}^{-1}\mathbf{W}_{d}'\Delta^{2}\ell\right\}, \ j = 1, 2, \tag{10}$$

where $\mathbf{d}_{it} = (d_{1,it}, d_{2,it})$; $\boldsymbol{\delta} = (\delta_1, \delta_2)'$, $\mathbf{V}_{1d} = \sum_{i=1}^{N} \mathbf{W}_{id}'\mathbf{G}\mathbf{W}_{id}$, $\mathbf{V}_{2d} = \sum_{i=1}^{N} \mathbf{W}_{id}'\Delta\hat{\mathbf{v}}_{i}\Delta\hat{\mathbf{v}}_{i}'\mathbf{W}_{id}$ with $\Delta\hat{\mathbf{v}}_{i} = \Delta^{2}\ell_{i} - \Delta\mathbf{d}\hat{\boldsymbol{\delta}}_{1d}$,

$$\mathbf{d} = \begin{bmatrix} \mathbf{d}_1 \\ \vdots \\ \mathbf{d}_N \end{bmatrix}_{N(T-2)\times 2}, \mathbf{d}_i = \begin{bmatrix} d_{1,i3}, d_{2,i3} \\ \vdots \\ d_{1,iT}, d_{2,iT} \end{bmatrix}_{(T-2)\times 2}, \ell = \begin{bmatrix} \ell_1 \\ \vdots \\ \ell_N \end{bmatrix}_{N(T-2)\times 1}, \ell_i = \begin{bmatrix} \ell_{i3} \\ \vdots \\ \ell_{iT} \end{bmatrix}_{(T-2)\times 1}$$

for $i = 1, ..., N$, and $\mathbf{G}$ is a $(T-2) \times (T-2)$ fixed matrix given by [15]

$$\mathbf{G} = \begin{bmatrix} 2 & -1 & 0 & \cdots & 0 & 0 \\ -1 & 2 & -1 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & 2 & -1 \\ 0 & 0 & 0 & \cdots & -1 & 2 \end{bmatrix}.$$

For any given threshold parameter, c and for large N, the GMM estimators derived in (10) are consistent and asymptotically normally distributed with covariance matrices given by $Var\left(\hat{\boldsymbol{\delta}}_{jd}\right) = \left\{\Delta\mathbf{d}'\mathbf{W}_{d}\mathbf{V}_{jd}^{-1}\mathbf{W}_{d}'\Delta\mathbf{d}\right\}^{-1}$, $j = 1, 2$.

Blundell and Bond (1998) demonstrate that the GMM estimator in linear dynamic panels is subject to the weak instruments problem, especially when the autoregressive coefficient

[15] If v_{it}'s are assumed to be homoskedastic, then the optimal GMM estimator can be computed in one step. when v_{it}'s are heteroskedastic, the weighting matrix should be estimated without imposing these restrictions.

is close to 1 and/or when the variance of the individual effects, σ_α^2, increases relative to the variance of the idiosyncratic error, σ_ε^2. We thus consider the following additional first-difference moment conditions for the level equations for $i = 1, ..., N$:

$$E\left(v_{it}\Delta z_{ji,t-s}\right) = 0 \text{ for } j = 1, 2;\ t = 3, ..., T \text{ and } 0 \le s \le t-3. \tag{11}$$

The system GMM estimator is obtained by combining the full moment conditions, $\mathbf{W}_{id}$, in differences equations and a nonredundant subset of moment conditions, $\mathbf{W}_{il}^{\min}$, in levels equation, where $\mathbf{W}_{il}^{\min} = \left(\mathbf{W}_{1i}^{l,\min}, \mathbf{W}_{2i}^{l,\min}\right)$ with $\mathbf{W}_{ji}^{l,\min}$ =diag$(\Delta d_{ji3}, ..., \Delta d_{jiT})$, $j = 1, 2$. We then obtain the following full set of moment matrix:

$$\mathbf{W}_S = \begin{bmatrix} \mathbf{W}_{1S} \\ \vdots \\ \mathbf{W}_{NS} \end{bmatrix},\ \mathbf{W}_{iS} = \begin{bmatrix} \mathbf{W}_{id} & \mathbf{0} \\ \mathbf{0} & \mathbf{W}_{il}^{\min} \end{bmatrix},\ i = 1, ..., N, \tag{12}$$

The one- and the two-step System-GMM estimators are obtained by

$$\hat{\boldsymbol{\delta}}_{jS} = \left\{\mathbf{X}'\mathbf{W}_S\mathbf{V}_{jS}^{-1}\mathbf{W}_S'\mathbf{X}\right\}^{-1}\left\{\mathbf{X}'\mathbf{W}_S\mathbf{V}_{jS}^{-1}\mathbf{W}_S'\mathbf{Y}\right\},\ j = 1, 2, \tag{13}$$

where $\mathbf{V}_{1S} = \sum_{i=1}^N \mathbf{W}_{iS}'\mathbf{H}\mathbf{W}_{iS}$, $\mathbf{H} = \begin{bmatrix} \mathbf{G} & \mathbf{0} \\ \mathbf{0} & \mathbf{I}_{T-2} \end{bmatrix}$, $\mathbf{V}_{2S} = \sum_{i=1}^N \mathbf{W}_{iS}'\hat{\mathbf{u}}_i\hat{\mathbf{u}}_i'\mathbf{W}_{iS}$, $\hat{\mathbf{u}}_i = \mathbf{Y}_i - \mathbf{X}_i\hat{\boldsymbol{\delta}}_{1S}$ and

$$\mathbf{X} = \begin{bmatrix} \mathbf{X}_1 \\ \vdots \\ \mathbf{X}_N \end{bmatrix}_{N(T-2)\times 2},\mathbf{X}_i = \begin{bmatrix} \Delta\mathbf{d}_i \\ \mathbf{d}_i \end{bmatrix}_{2(T-2)\times 2},\mathbf{Y} = \begin{bmatrix} \mathbf{Y}_1 \\ \vdots \\ \mathbf{Y}_N \end{bmatrix}_{N(T-2)\times 1},\mathbf{Y}_i = \begin{bmatrix} \Delta^2\ell_i \\ \Delta\ell_i \end{bmatrix}_{2(T-2)\times 1}$$

for $i = 1, ..., N$. For a given c and for large N, $\hat{\boldsymbol{\delta}}_{1S}$ and $\hat{\boldsymbol{\delta}}_{2S}$, are consistent and asymptotically normally distributed with covariance matrices, $Var\left(\hat{\boldsymbol{\delta}}_{jS}\right) = \left\{\mathbf{X}'\mathbf{W}_S\mathbf{V}_{jS}^{-1}\mathbf{W}_S'\mathbf{X}\right\}^{-1}$, $j = 1, 2$.

The threshold parameter, c in (5) will be consistently estimated using a grid search over the transition variable; namely[16]

$$\hat{c} = \arg\min_{\gamma} Q\left(c\right), \tag{14}$$

where $Q\left(c\right)$ is the generalized minimum distance measure given by:

$$Q\left(c\right) = \Delta\hat{\mathbf{v}}\left(c\right)'\mathbf{W}\left(c\right)\mathbf{V}_2\left(c\right)^{-1}\mathbf{W}\left(c\right)'\Delta\hat{\mathbf{v}}\left(c\right),\ \Delta\hat{\mathbf{v}}\left(c\right) = \Delta^2\ell - \Delta\mathbf{d}\left(c\right)\hat{\boldsymbol{\delta}}_{2d}\left(c\right). \tag{15}$$

In essence, the algorithm requires that the threshold parameter takes a value on the grid set that minimizes the generalized minimum distance, $Q\left(c\right)$, given by (15). Note that the grid search should not consist of all the support of the transition variable but be bounded. The use of the cut-off points at 15th and 85th percentiles is empirically recommended because it removes potential extreme values of the transition variable and ensures sufficient number of observations and degrees of freedom in each regime, e.g. Hansen (1999).[17]

[16]Notice that $\Delta\hat{\mathbf{v}}$, $\mathbf{W}_d$, $\mathbf{V}_{2d}$, $\Delta\mathbf{d}$, $\hat{\boldsymbol{\delta}}_{2d}$ in the definition of $Q_1\left(c\right)$, all depend on the threshold parameter, c, so now we make their dependence explicitly.

[17]We have also examined a wider grid search bounded by the 10th and 90th percentiles and obtained qualitatively similar results.

4.2 Data

We analyze a panel of the U.K. firms collected from Datastream. The initial sample includes 1,683 firms. The accounting variables for all the firms are collected from the earliest possible year to January 2004, resulting in an unbalanced panel data set of nearly 20,000 year-observations. Following the previous studies in the literature, a number of the data filtering are applied. First, firms operating in financial sectors (banks, insurance and life assurance companies and investment trusts) and in utility sectors (electricity, water and gas distribution) are excluded since they are subject to different accounting considerations. Second, in order to use the dynamic GMM estimators that require the use of lagged instruments, only companies that have at least five-years of observations are retained. Finally, observations that have many missing data are removed.[18]

Our final sample consists of 859 companies and 5,393 year-observations, with the longest time series of 8 years over the period 1996-2003. Descriptive statistics for the variables and the structure of the sample and are provided in Table 2 and Table 3, respectively.

5 Empirical Results

We first report the estimates for all sample obtained by both one-step and two-step procedures. Next, our analysis focuses on the results for the proposed threshold partial adjustment model.

Table 4 reports the results for both static and dynamic models of leverage given, respectively, by (2) and (3) using alternative estimators. Overall examination of the three dynamic estimators, denoted AH-IV, GMM and SYSGMM, shows that the results are appropriate with most of the coefficients on the control variables being significant and having the expected signs. Growth is found to be negative at the 1% significant level, a finding consistent with the prediction that high-growth firms lower leverage in order to mitigate the under-investment problem (Myers, 1977). The coefficient on non-debt tax shields is significantly negative, supporting the hypothesis that non-debt tax shields are a substitute for the tax benefits of debt so firms with high non-debt tax shields are predicted to have less debt (DeAngelo and Masulis, 1980). The coefficient on profitability is significantly negative, which is consistent with the prior empirical evidence, e.g. Titman and Wessels (1988) and Rajan and Zingales (1995).[19] The coefficient on tangibility is significantly positive, supportive of the hypothesis that tangibility can be used as a security to avoid the asset substitution problem and reduce the agency costs of debt (Frank and Goyal, 2005). Firm size has a significantly positive coefficient, a finding consistent with the prediction that large firms face low bankruptcy, agency and transaction costs and thus are less vulnerable to informational asymmetries and adverse selection, hence resulting in an easier access to the capital market (Frank and Goyal, 2005).

Turning to the dynamic specification, we find that the coefficient on lagged leverage is significantly positive at the 1% level in all the three models, though the magnitude varies between 0.38 and 0.79. The AH-IV and the GMM results suggest a fast speed of adjustment with more than 50-60% of the deviation from target leverage being closed within a year. The implied adjustment speed is only 20% according to the SYSGMM estimation approach,

[18] A large number of companies are dropped due to the missing items in the cash flow statements.

[19] Notice that this finding is in line with both the pecking order theory (Myers, 1984) and the dynamic trade-off theory of capital structure (Strebulaev, 2007).

though the Sargan test suggests the instruments used in the SYSGMM estimator may be invalid.

To further examine the robustness of the results obtained using the one-step approach based on (3), we also estimate the partial adjustment model of leverage using the two-stage procedure based on (2). This involves estimating (1) with the estimated target leverage obtained from the regression of leverage on conventional determinants given by (2).[20] Five alternative estimators are considered for estimating (1), and the results are reported in Table 5. The estimated speed of adjustment, which is the coefficient on the distance between target leverage and lagged leverage, is positive and significant at the 1% level in all the five models. The size of the estimates varies between 0.44 and 0.67, demonstrating that the U.K. firms on average adjust their capital structures at a relatively quicker adjustment speed, as compared to the US counterparts. These results are generally consistent with those obtained from the one-stage procedure (except the SYSGMM results).[21] Overall this evidence is more or less consistent with previous evidence (e.g. Ozkan, 2001; Antoniou et al., 2007), and provides further support for the trade-off framework that predicts a relatively quick speed of adjustment.

5.1 Deviation from Target Leverage

Our previous discussion suggests that the presence of costly adjustment makes it difficult for firms to adjust toward an optimal capital structure frequently and continuously as modeled implicitly by the partial adjustment framework. The results discussed above assume that adjustment paths are symmetric, and thus reflect the average speed of adjustment, neglecting an important issue as to whether firms facing differential adjustment costs undertake different adjustment paths. We now turn to discuss the empirical results obtained from the proposed threshold panel-data model, (4). We consider two different measures of the deviation from target leverage as the transition variable; the absolute deviation and the absolute deviation ratio.

The impact of the absolute deviation from target leverage on the speed of adjustment is theoretically ambiguous as discussed in subsection 3.1, and should therefore be resolved empirically. Notice that in the case where the unobserved heterogeneous individual effects are assumed to be correlated with the regressors, only the AH-IV, the GMM and the SYSGMM estimators are consistent with GMM and SYSGMM being more efficient, see Arellano and Bond (1991), Blundell and Bond (1998) and Shin (2007). For this reason, we focus our interpretations on these estimators.

Panel A of Table 6 presents the estimate of the threshold parameter together with main estimation results respectively for the low and high regimes where the low (high) regime is determined when the transition variable is less (greater) than the threshold value. We find that the adjustment speed in a low regime is significantly higher than that in a high regime (except in the AH-IV column), supporting our prediction that asymmetry exists

[20] Notice that the FE estimates are used, see the results in column 2 of Table 4. In our robustness checks, we have also used the pooled OLS estimates of the target leverage. The results are qualitatively similar.

[21] This statement is still valid even after discounting inconsistent estimation results by OLS and FE and noticing that the validity of the instruments used in both GMM and SYSGMM is strongly rejected by the Sargan tests. In this case we may still argue that the AH-IV estimate is more or less reliable. Considering that all the adjustment speed coefficients for AH-IV, GMM and SYSGMM are very similar at 0.44, we may search for the set of instruments for GMM and SYSGMM, the validity of which are not rejected by the data.

in capital structure adjustment such that firms deviating further away from their optimal capital structures undertake slower adjustment due to higher adjustment costs. The GMM estimation results, marginally supported by both the Sargan and AR(2) tests,[22] suggest that the speed of adjustment is 73% and 44% for firms with small and large deviations, respectively. Notice, however, this finding is inconsistent with Drobetz et al. (2006).

We further examine the differential speed of adjustment when the regime-switching variable used is the ratio of the absolute deviation to the target leverage, i.e., the percentage of the deviation from the target leverage, which we find has an important qualitative advantage over the absolute deviation.[23] The results reported in Table 7 suggest that firms with a small deviation ratio adjust leverage significantly more quickly, though adjustment magnitudes depend on the choice of the estimator. Firms with a small (large) absolute deviation ratio adjust toward target leverage at rate of more than 74% (42%) in the SYSGMM estimation. However, the Sargan test result indicates that SYSGMM estimation is not valid, suggesting that these estimates are misleading.[24] Turning to the valid GMM estimation results, we find that the low- and high-regime adjustment speed estimates are 57% and 33%, respectively. Overall, this evidence is qualitatively similar to those obtained in Table 6 where the absolute deviation is used as a transition variable.

We next examine the characteristics of the firms in each regime reported in Panel B of Table 7. The results show that firms with a low deviation ratio are significantly more mature and slightly larger, as compared to firms with a high deviation ratio. In addition, leverage, tangibility, profitability and debt capacity of these firms are significantly higher while their growth opportunities and investments are significantly lower. In contrast, firms with a large deviation ratio are younger, lowly-leveraged, limited in cash reserves and less profitable but have considerable growth options and investment sets. This characteristic classification supports our prediction that firms with a large deviation ratio may not be able to make capital structure adjustment sufficiently quickly due to high adjustment costs, once the actual leverage is above a certain threshold.[25] Turning to the patterns of external financing activity of the firms in each regime, we find that firms that adjust more slowly (i.e. with a large deviation ratio) have a larger cash-flow deficit, which they offset by issuing both equity and debt aggressively. There is also evidence that these firms rely more on equity issuance than debt issuance, consistent with the observation that they have high growth options to finance while maintaining a low-leverage policy.[26] Overall, this finding suggests that firms deviating too far away from the target leverage will undertake slower capital structure adjustment despite their active external financing operation.

[22] We also provide the Sargan and AR(2) test results to check the validity of the instruments.

[23] For illustration, suppose that the absolute deviation is 20% for two firms A and B, whose target leverage ratios are equal to 25% and 50%, respectively. Estimating the threshold model using the absolute deviation of 20% as the transition variable does not recognize the fact that firm A is deviating significantly from the target leverage with a deviation ratio of 80% whereas firm B is deviating moderately with a deviation ratio of 40%. It is thus reasonable to predict that the speed of capital structure adjustment differs for these two firms with the same absolute deviation.

[24] Throughout the whole analysis, the validity of |SYSGMM estimator is all rejected whereas the validity of |GMM estimator is not rejected at least at 1% significance level.

[25] It will be interesting to see whether the deviation ratio can also be used as the distress measure of the firms and how its performance can be compared to the commonly used measures such as Altman's (1968) Z-score and Ohlson's (1980) O-score.

[26] This financing pattern is inconsistent with the pecking order theory.

5.2 Internal Financial Constraints

Panel A of Table 8 contains the estimation results for the dynamic threshold model with firm profitability used as the transition variable. Firms with low profitability adjust their capital structures more quickly as compared to firms with high profitability (notice that the difference appears to be small in the (invalid) SYSGMM estimation). This finding is inconsistent with the prediction that highly profitable firms, with available internal funds, potentially high tax shields and high financial flexibility, are able to make capital structure adjustment more quickly (Flannery and Hankins, 2007).[27] Since this finding is difficult to explain on a theoretical ground, we turn to investigate the firm characteristics in each regime. The results in Panel B show that less profitable firms are typically younger and smaller but this remains unclear as why these firms have a faster speed of adjustment. Importantly, we find that these firms have significantly high leverage (except in the AH-IV column) and a high debt capacity usage. These characteristics provide a partial explanation for our puzzling finding. Having high leverage may result in high bankruptcy costs and this may therefore force the firm to undertake more rapid adjustment. We also find that the firms with low profitability have large cash-flow deficits, which are then offset by active equity issuances. At the same time, their net debt issued is negative, suggesting that these firms are, on average, retiring debts even when they need to raise external finance to offset the financing deficit. These results are inconsistent with the pecking order theory and suggest that less profitable firms can change their capital structures more frequently through active issuances of equity.

We next examine whether internal financial constraints measured by dividend payments (payout ratios) and investment strategies have any effects on the speed of capital structure adjustment, and summarize the results in Panel A of Table 9. The adjustment speed is significantly higher for firms with a low payout ratio, a finding consistent with our prediction that firms facing lower internal financial constraints adjust toward target leverage more quickly. Further analysis of the firm characteristics reported in Panel B shows that firms with a low payout ratio are relatively young and small entities that have significantly high leverage but low profitability, tangibility and limited cash reserves. These 'low-quality' firms also have a large cash flow deficit, the major part of which is offset by net equity issued. As with less profitable firms, we observe similar characteristics of firms that appear to undertake more frequent capital structure adjustment.

In Table 10, with the level of firm investment selected as the regime-switching variable, we find similar results, supporting the hypothesis that firms with less internal financial constraints have a faster adjustment speed. Further inspection of Panel B shows that firms with a low level of investment share similar characteristics with firms with a low payout ratio: relatively high leverage, high tangibility, low profitability and limited growth options (a small number of exceptions in the GMM and SYSGMM results). These characteristics are typically observed in 'low quality' firms who may face high distress costs and thus have a strong incentive to undertake quick capital structure adjustment. Finally, firms with less investment have some cash flow surpluses that allow them to retire debt as indicated by negative average net debt issued.

[27] We have also considered cash flow as a related but alternative measure of internal financial constraints and obtain qualitatively similar results, i.e., cash flow is negatively related to the speed of adjustment.

5.3 Growth Opportunities and External Financial Constraints

While the theoretical prediction is ambiguous, the results summarized in Table 11 show that low-growth firms adjust their capital structures more quickly than high-growth firms, a finding inconsistent with Drobetz et al. (2006). In the AH-IV estimation, the speed of adjustment is found to be approximately 54% for low-growth firms and 32% for high-growth firms. Note that the GMM and SYSGMM results show smaller estimates of adjustment speeds for both types of firms, though the difference between the adjustment speeds in the high and low regimes remains significant.

To further investigate why low-growth firms have a faster speed of adjustment, we turn to Panel B and find that low-growth firms are typically mature, cash-rich and highly profitable. These characteristics can be considered as those of 'high-quality' firms, implying a lower degree of the asymmetric information and agency problems and easier access to the capital market. Further, low-growth firms also have significantly higher leverage, a finding consistent with both the under-investment hypothesis (Myers, 1977) and the free cash flow hypothesis (Jensen, 1986). High-leverage is generally associated with high bankruptcy and liquidation costs so firms with high leverage may opt for frequent capital structure adjustment rather than leaving leverage to deviate considerably away from the target leverage.[28] Low-growth firms are also found to be much less active in the equity market than high-growth firms, and this observation is appropriate given the latter firms' significantly larger financing deficits (to finance more growth options). Finally, low-growth firms maintain a low payout ratio and use available retained earnings to make debt retirement as indicated by the negative net debt issued, suggesting that capital structure adjustment for these firms may mainly take the form of internal adjustment.

We next investigate how external financial constraints, as proxied by firm size and stock price movements, may affect the speed of capital structure adjustment. From a theoretical perspective, large firms are generally mature companies that have high tangibility, profitability and financial flexibility. They also have lower asymmetric information costs, face less severe adverse selection and moral hazard problems and, thus, have better access to the capital market. Large firms face a relatively low fixed cost of adjustment, implying a higher speed of adjustment. The results in Panel B of Table 12 support the above predictions that firm size is positively associated with firm age, leverage, profitability and cash flow. Large firms are, however, less active in the capital market than small firms as evident by limited net debt and equity issues. Further, the results in Panel A are mixed as the AH-IV results show a positive association between firm size and the adjustment speed while the GMM and SYSGMM results suggest the opposite, i.e., large firms have a slower speed of adjustment. This latter finding is inconsistent with our prediction, which may be partially explained by different threhsold estimates selected by different estimators, for example, 80% (20%) and 31% (69%) of firms being classified to the low (high) regime respectively for AH-IV and GMM.

Table 13 reports the results for the speed of adjustment for firms with differential stock price movement paths. Although the relationship between stock price changes and the speed of adjustment is theoretically ambiguous, we find that firms experiencing a decline in their stock prices undertake quicker adjustment. Thus, we do not find support for the argument that stock price increases signal 'high-quality' and allow firms to access the financial market

[28] This is especially important for over-leveraged firms whose actual leverage is higher than the target leverage, leading to potentially high bankruptcy costs.

more cheaply and adjust leverage more easily. On the other hand, stock price decreases may lead to a higher leverage ratio and so for over-leveraged and 'low quality' firms, there are more incentives to retire debt and revert back to the target leverage. The results in Panel B appear to support this hypothesis as stock price decreases are indeed observed in highly leveraged, less profitable and low-growth firms that tend to disinvest and attempt to retire their debt.

5.4 Further Considerations - Financing Deficit and Financial Distress

Byoun (2008) estimates a financing-needs-induced adjustment framework in which the (asymmetric) speed of adjustment is determined by the degree of financing deficits or surpluses and the deviation from the target leverage. The paper documents a fast speed of adjustment for firms that have under-target debt (over-target debt) and, at the same time, experience financing deficits (surpluses). This suggests that firms use their financing surpluses to repay the debt when they are overleveraged while firms raise more debt to offset their financing deficits especially when they are under-leveraged. Overall, it is observed that the speed of adjustment is conditional on the firm's financing deficit/surplus. To evaluate this hypothesis in the context of our framework, we re-estimate the dynamic threshold model using firms' financing deficit as the transition variable. The GMM and SYSGMM results in Panel A of Table 14 show that firms with a financing deficit (surplus) are found to undertake faster (slower) adjustment toward their optimal capital structures. The AH-IV results, however, display a conflicting picture as the speed of adjustment is faster when firms have a financing surplus. Overall, it can be concluded that the speed of adjustment varies with financing deficit, though the evidence is somewhat mixed.[29]

The cost of financial distress may play an important role in determining capital structure decisions. Firms facing a high probability of distress should make quicker adjustment toward their target leverage, especially when they have too much debt (Flannery and Hankins, 2007). To proxy for the probability of financial distress, we utilize the U.K.-based version of the Altman's (1968) z-score derived by Taffler (1984) as follows:[30]

$$Zscore = 3.20 + 12.18 \times X_1 + 2.50X_2 - 10.68 \times X_3 + 0.024 \times X_4 \tag{16}$$

where X_1 is the ratio of profit before tax to current liabilities, X_2 the ratio of current assets to total liabilities, X_3 the current liabilities to total assets and X_4 the number of credit interval, measured by quick assets less current liabilities, all divided by the sum of sales less profit before tax less depreciation divided by 365. According to Taffler (1984), firms with a positive (negative) z-score are classified as having potentially low (high) bankruptcy risk.

In Panel B of Table 14, we present the estimate of the adjustment speed conditional on the variation in the z-score. The results in the AH-IV and SYSGMM estimations show that firms with a lower z-score have a faster speed of adjustment, consistent with our prediction.

[29] We obtain different threshold estimates using alternative estimators, for example, the AH-IV classifies 15% of the firm-observations into the low regime while the GMM and SYSGMM classifies 50% into the low regime.

[30] The use of this z-score may suffer from a potential sample bias problem. To overcome this issue, we also employ alternative proxies for financial distress such as the insolvency measure suggested by Pindado et al. (2007). The (unreported) results are insignificant and inconclusive.

However, the evidence is not robust as the difference of the estimates in the low and high regimes is small and economically insignificant in the GMM estimation. [31]

Finally, we investigate the effect of being under or over the target leverage on dynamic capital structure adjustment. Our empirical analyses in the previous sections have revealed a pattern in which firms adjusting quickly are generally associated with high leverage. Theoretically, over-leveraged firms are likely to face a higher financial distress cost and therefore have more incentive to revert back to the target leverage quickly. In this context, over-leverage (under-leverage) can be considered as an alternative measure of distress, in addition to the z-score. The results reported in Panel C support our hypothesis and show clearly that over-leveraged firms tend to adjust toward the target leverage much more quickly than under-leveraged firms. Empirically this finding is consistent with our observation in the previous sections, and lends further support to the overall evidence on asymmetric adjustment speeds.[32]

6 Conclusions

The dynamic trade-off theory suggests that capital structure adjustment toward target leverage for firms facing differential adjustment costs may take different paths, thereby rendering the speed of adjustment heterogeneous. However, existing empirical studies based on the conventional partial adjustment framework generally assumes a homogeneous speed of adjustment. In this paper we have developed a new empirical approach to testing the dynamic trade-off theory by allowing for costly adjustment of leverage and asymmetries in capital structure adjustment paths. The proposed dynamic threshold model of leverage embeds a partial adjustment process and enables one to estimate the heterogeneous speeds of adjustment in two separate regimes associated with differential adjustment costs.

We have examined several transition variables that potentially affect capital structure adjustment costs, including the deviation (ratio) from the target leverage, profitability, payout ratio, firm investment, growth options, firm size, stock price movements, financing deficit and z-score. Our empirical results suggest that firms deviating far away from the target leverage may face high adjustment costs, which impede rapid adjustment toward the target leverage; whilst firms with a small deviation ratio tend to undertake quicker adjustment. Internal financial constraints, as measured by the dividend payout ratio and firm investment, are found to reduce the speed of adjustment. We also document that low-growth firms adjust toward target leverage significantly more quickly than high-growth firms, and this finding is supported by the observation that the former firms process the characteristics of "quality" firms and consequently have easier access to the capital market. We do not, however, find conclusive evidence for the hypothesis that external financial constraints have negative impact on the speed of adjustment. Interestingly, the major body of results points out that a fast speed of adjustment is observed in firms adopting a high leverage policy (e.g. being over-leveraged) and potentially facing high bankruptcy and liquidation costs. Overall we have provided strong evidence for heterogeneous speeds of adjustment and asymmetric paths, a finding consistent with the dynamic trade-off theory of capital structure.

[31] This finding may be due to different threshold estimates selected by alternative estimators; for example, 56% and 22% of firms are classified to the high regime for the AH-IV and GMM estimations, respectively.

[32] We have also examined tangibility as an alternative measure of financial distress because tangibility and collateral are argued to help reduce the cost of distress. However, we do not observe a significant association between the speed of adjustment and tangibility.

While the empirical framework developed in this paper is capable of examining the dynamic trade-off theory, it does not capture the predictions of the pecking order theory and other alternative theories of capital structure. Extant empirical research suggests that dynamic rebalancing may be consistent with both the trade-off and the modified pecking order theory (Leary and Roberts, 2005). It would be interesting to generalize our empirical model into a unifying framework that nests and tests alternative theories of capital structure.

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Table 1: Proxies of Variables

Variables	Proxies
Leverage	Total debt to the market value of equity plus book value of debt
Tangibility	Fixed assets to total assets
Growth Opportunities	Market value of equity plus book value of debt to total assets
Profitability	Earnings Before Interest and Depreciation (EBITD) to total assets
Non-debt Tax Shields	Depreciation to total assets
Size	Log of total assets in 1995 price
Dividend Ratio	Ordinary dividends to total assets
Investment	Capital expenditure less depreciation divided by fixed assets
Debt Capacity	Total debt to net fixed assets
Age	Age of the firm (from Start date to 2003)
Deviation	Distance between actual leverage and target leverage
Absolute Deviation	Deviation in absolute values
Absolute Deviation Ratio	Absolute deviation to target leverage
Cash Flow	EBITDA plus depreciation divided by total assets
Net Debt Issued	Net debt issued to the firm's market value
Net Equity Issued	Net equity issued to the firm's market value
Cash Flow Deficit	Minus Cash flows after tax plus Net investment (incl. Capital Expenditures, Acquisitions and Disposals) plus Equity dividends plus Net change in cash including change in working capital, all divided by the firm's market value

Notes: The data set is a panel of the U.K. firms collected from Datastream and consists of 859 companies and 5,393 year-observations, with the longest time series of 8 years over the period 1996-2003.

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Median	Max	Skewness	Kurtosis
Leverage	0.200	0.199	0.000	0.146	0.990	1.104	3.750
Tangibility	0.310	0.243	0.000	0.256	0.997	0.846	2.903
Non-debt Tax Shields	0.039	0.031	0.000	0.033	0.204	1.947	8.816
Profitability	0.014	0.266	-1.495	0.079	0.446	-3.213	16.255
Growth	2.043	2.216	0.188	1.363	20.000	4.556	30.326
Size	11.189	2.105	1.609	11.012	18.961	0.343	3.167
Dividend Ratio	0.025	0.029	0.000	0.019	0.217	2.898	16.082
Investment	0.043	0.665	-3.710	0.022	3.840	0.125	23.768
Debt Capacity	2.131	10.085	0.000	0.504	129.267	11.001	134.289
Age	21.270	12.374	5.000	18.000	43.000	0.480	1.692
Cash Flow	0.066	0.242	-1.202	0.118	0.490	-2.778	13.258
Net Debt Issued	-0.005	0.097	-0.540	-0.001	0.358	-1.167	11.891
Net Equity Issued	0.054	0.169	-0.175	0.001	1.133	3.926	20.030
Cash Flow Deficit	0.024	0.143	-0.690	0.001	0.645	0.296	10.049

Notes: See Table 1 for the definitions of the variables. To avoid the effect of outliers, we follow winsorise the variables at the 1st and 99th percentiles.

Table 3: Structure of the Panel Data

Panel A

Year	Number of Observations	% of the Sample
1996	169	3
1997	742	14
1998	832	15
1999	858	16
2000	858	16
2001	857	16
2002	831	15
2003	242	4
Total	5,389	Panel B

Panel B

Number of year observations	Number of Observations	% of the Sample
5	78	9
6	464	54
7	313	36
8	3	0
Total		

Table 4: Static and Dynamic Models of Target Leverage

Dependent variable: Leverage

Independent variables	Exp. Sgn.	Static Model POLS	FE	Dynamic Model AH-IV	GMM	SYSGMM
Leverage(t-1)	+	-	-	0.470***	0.403***	0.785***
		-	-	(0.068)	(0.074)	(0.031)
Growth(t)	-	-0.027***	-0.010***	-0.009***	-0.008***	-0.011***
		(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Non-debt tax shields(t)	-	-0.273***	0.380***	-0.649***	-0.549**	-0.481***
		(0.089)	(0.140)	(0.225)	(0.225)	(0.105)
Profitability(t)	+/-	-0.134***	-0.134***	-0.124***	-0.115***	-0.090***
		(0.011)	(0.014)	(0.017)	(0.017)	(0.014)
Size(t)	-	0.015***	0.060***	0.050***	0.051***	0.008***
		(0.001)	(0.004)	(0.009)	(0.009)	(0.001)
Tangibility(t)	+	0.200***	0.154***	0.241***	0.231***	0.089***
		(0.013)	(0.030)	(0.049)	(0.050)	(0.013)
No of observations		5,389	5,389	3,673	3,673	4,531
Time dummies		No	No	Yes	Yes	Yes
R-squared		0.213	0.115	-	-	-
Hausman Test		-	337.87***	-	-	-
Wald test		-	-	550.33***	538.17***	2365.50***
AR(2) test		-	-	-1.48[0.14]	-1.51[0.13]	-1.16[0.24]
Sargan test		-	-	-	23.82[0.25]	48.20[0.00]

Notes: This table presents the results for the static and dynamic models of leverage, based on equations (2) and (3), respectively. Columns POLS and FE stand for Pooled OLS and Fixed Effects estimators. Column AH-IV employs the AH-IV estimation method, using the second lagged leverage as the instrument for the rst lagged leverage. Columns GMM and SYSGMM are the two-step GMM and SYSGMM estimators, using from the second lagged leverage as the instruments for rst the lagged leverage. Wald test is a test for joint signicance of the estimated coefficients under the null of no relationship, asymptotically distributed χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 5: Partial Adjustment Models of Target Leverage

DependentVariable: Leverage in First Differences

	POLS	FE	AH-IV	GMM	SYSGMM
Adjustment Speed	0.667***	0.625***	0.439***	0.444***	0.445***
	(0.021)	(0.023)	(0.033)	(0.026)	(0.029)
First differences	No	No	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes
No of observations	4,531	4,531	3,673	3,673	4,531
R-squared	0.37	0.37	-	-	-
Wald test	151.46***	117.28***	238.97***	362.29***	321.60***
AR(2) test	-	-	-1.29[0.20]	-1.24[0.22]	-1.23[0.22]
Sargan test	-	-		43.70[0.00]	69.51[0.00]

Notes: This table presents the results for the two-step estimation of the partial adjustment model, based on equation (1). Columns POLS and FE employ the Pooled OLS and Fixed Effects estimators.Column AH-IV employs the AH-IV estimation method, using lagged distance to target leverage ($d_{i,t-1}$) as the instrumental variable for the distance to target leverage ($d_{i,t}$) where $d_{i,t}$ is the distance between the target leverage and past leverage. Columns GMM and SYSGMM are the two-step GMM and System GMM (SYSGMM) estimators, using the second lagged leverage as instruments for rst the lagged leverage. Wald test is a test for joint signicance of the estimated coefficients under the null of no relationship, asymptotically distributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 6: Heterogeneous Adjustment Speeds for Firms Deviating from Target Leverage

Panel A – Partial Adjustment Model of Leverage
Transition Variable: First Lagged Absolute Deviation

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.439***	0.439***	0.732***	0.439***	0.702***	0.442***
	(0.046)	(0.044)	(0.115)	(0.026)	(0.111)	(0.029)
Threshold (Percentile)	0.129(83)		0.014(16)		0.014(16)	
Number of Observations	3,761	1,628	725	4,664	725	4,664
Wald Test	251.86***		372.62***		333.93***	
AR(2) Test	-1.29[0.20]		-1.24[0.22]		-1.23[0.22]	
Sargan Test	-		57.54[0.03]		89.65[0.00]	

Panel B – Firm Characteristics in Each Regime

Firm Characteristics	Low	High	Low	High	Low	High
Leverage	0.201	0.311	0.137	0.235	0.137	0.235
Age	21.244	21.300	21.037	21.297	21.037	21.297
Tangibility	0.308	0.310	0.292	0.311	0.292	0.311
Profitability	0.015	-0.089	0.045	-0.011	0.045	-0.011
Growth	2.000	1.714	2.120	1.920	2.120	1.920
Size	11.395	10.843	11.281	11.311	11.281	11.311
Dividend Payout Ratio	0.025	0.015	0.031	0.021	0.031	0.021
Investment	0.046	-0.118	0.085	0.006	0.085	0.006
Cash Flow	0.069	-0.023	0.095	0.046	0.095	0.046
Debt Capacity	1.522	2.572	0.137	0.235	0.137	0.235
Deviation	0.009	0.010	0.001	0.010	0.001	0.010
Absolute Deviation	0.064	0.135	0.041	0.082	0.041	0.082
Absolute Deviation Ratio	0.610	0.523	0.699	0.575	0.699	0.575
Financing Deficit	0.019	0.016	0.019	0.018	0.019	0.018
Net Debt Issued	-0.003	-0.021	0.001	-0.007	0.001	-0.007
Net Equity Issued	0.042	0.053	0.036	0.045	0.036	0.045

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used is the first lagged deviation in absolute values. 15th - 85th percentiles of the transition variable are 0.013 - 0.139 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 7: Heterogeneous Adjustment Speeds for Firms Deviating Proportionally from Target Leverage

Panel A – Partial Adjustment Model of Leverage
Transition Variable: First Lagged Absolute Deviation Ratio

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.565***	0.353***	0.567***	0.327***	0.736***	0.417***
	(0.054)	(0.042)	(0.041)	(0.039)	(0.083)	(0.030)
Threshold (Percentile)	0.637(62)		0.571(58)		0.190(15)	
Number of Observations	2,278	3,111	2,131	3,258	551	4,838
Wald Test	247.90***		424.37***		347.44***	
AR(2) Test	-1.54[0.12]		-1.51[0.13]		-1.39[0.16]	
Sargan Test	-		41.62[0.17]		114.14[0.00]	

Panel B – Firm Characteristics in Each Regime

Firm Characteristics	Low	High	Low	High	Low	High
Leverage	0.290	0.103	0.295	0.113	0.343	0.197
Age	23.642	17.356	23.739	17.821	24.182	20.737
Tangibility	0.358	0.227	0.361	0.235	0.374	0.296
Profitability	0.034	-0.060	0.035	-0.053	0.047	-0.011
Growth	1.549	2.612	1.545	2.517	1.452	2.042
Size	11.819	10.468	11.848	10.557	11.912	11.199
Dividend Payout Ratio	0.023	0.023	0.023	0.023	0.021	0.023
Investment	-0.026	0.095	-0.025	0.082	-0.017	0.026
Cash Flow	0.086	0.002	0.087	0.009	0.097	0.047
Debt Capacity	1.847	1.441	2.470	2.012	3.717	2.024
Deviation	0.020	-0.010	0.020	-0.007	0.029	0.005
Absolute Deviation	0.080	0.068	0.080	0.069	0.079	0.075
Absolute Deviation Ratio	0.409	0.901	0.400	0.867	0.347	0.640
Financing Deficit	0.001	0.046	0.000	0.043	0.005	0.020
Net Debt Issued	-0.010	0.002	-0.012	0.002	-0.003	-0.006
Net Equity Issued	0.016	0.090	0.015	0.083	0.013	0.049

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used is the first lagged deviation ratio in absolute values. 15th - 85th percentiles of the transition variable are 0.019 - 1 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 8: Profitability and Heterogeneous Adjustment Speeds

Panel A – Partial Adjustment Model of Leverage
Transition Variable: Profitability

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.519***	0.307***	0.472***	0.319***	0.461***	0.425***
	(0.042)	(0.051)	(0.031)	(0.062)	(0.033)	(0.066)
Threshold (Percentile)	0.079(50)		0.115(67)		0.117(68)	
Number of Observations	2,697	2,692	3,611	1,778	3,665	1,724
Wald Test	250.43***		374.03***		336.33***	
AR(2) Test	-1.21[0.28]		-1.16[0.25]		-1.23[0.22]	
Sargan Test	-		55.51[0.04]		96.14[0.00]	

Panel B – Firm Characteristics in Each Regime

Firm Characteristics	Low	High	Low	High	Low	High
Leverage	0.262	0.166	0.258	0.120	0.257	0.117
Age	20.307	22.407	21.179	21.439	21.206	21.376
Tangibility	0.298	0.320	0.314	0.292	0.314	0.292
Profitability	-0.127	0.150	-0.075	0.182	-0.073	0.184
Growth	1.834	2.099	1.769	2.416	1.768	2.437
Size	10.902	11.797	11.183	11.612	11.192	11.602
Dividend Payout Ratio	0.012	0.036	0.015	0.044	0.015	0.044
Investment	-0.016	0.063	-0.001	0.071	0.001	0.070
Cash Flow	-0.063	0.197	-0.016	0.229	-0.014	0.232
Debt Capacity	1.833	1.522	2.446	1.857	2.435	1.866
Deviation	0.023	-0.009	0.019	-0.016	0.019	-0.017
Absolute Deviation	0.094	0.053	0.086	0.048	0.086	0.047
Absolute Deviation Ratio	0.584	0.610	0.536	0.746	0.537	0.749
Financing Deficit	0.034	-0.001	0.029	-0.009	0.028	-0.009
Net Debt Issued	-0.009	-0.002	-0.006	-0.006	-0.006	-0.006
Net Equity Issued	0.072	0.009	0.059	0.006	0.058	0.006

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used is profitabiltiy. 15th - 85th percentiles of the transition variable are -0.111 - 0.167 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 9: Dividend Payout Ratio and Heterogeneous Adjustment Speeds

Panel A – Partial Adjustment Model of Leverage
Transition Variable: Dividend Payout Ratio

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.471***	0.306***	0.455***	0.223**	0.455***	0.322***
	(0.037)	(0.074)	(0.028)	(0.104)	(0.031)	(0.096)
Threshold (Percentile)	0.028(68)		0.038(79)		0.038(79)	
Number of Observations	3,559	1,830	4,258	1,131	4,258	1,131
Wald Test	246.89***		351.36***		312.16***	
AR(2) Test	-1.21[0.23]		-1.18[0.24]		-1.19[0.23]	
Sargan Test	-		62.25[0.01]		94.89[0.00]	

Panel B – Firm Characteristics in Each Regime

Firm Characteristics	Low	High	Low	High	Low	High
Leverage	0.252	0.146	0.244	0.114	0.244	0.114
Age	20.049	23.871	20.760	23.296	20.760	23.296
Tangibility	0.302	0.320	0.307	0.312	0.307	0.312
Profitability	-0.062	0.128	-0.037	0.145	-0.037	0.145
Growth	1.902	2.065	1.862	2.331	1.862	2.331
Size	11.062	11.836	11.211	11.700	11.211	11.700
Dividend Payout Ratio	0.010	0.052	0.013	0.064	0.013	0.064
Investment	0.006	0.050	0.009	0.065	0.009	0.065
Cash Flow	-0.004	0.180	0.019	0.198	0.019	0.198
Debt Capacity	1.996	1.033	2.521	1.271	2.521	1.271
Deviation	0.016	-0.006	0.014	-0.012	0.014	-0.012
Absolute Deviation	0.087	0.051	0.083	0.044	0.083	0.044
Absolute Deviation Ratio	0.582	0.627	0.570	0.705	0.570	0.705
Financing Deficit	0.031	-0.010	0.026	-0.014	0.026	-0.014
Net Debt Issued	-0.007	-0.004	-0.006	-0.005	-0.006	-0.005
Net Equity Issued	0.063	0.001	0.055	-0.002	0.055	-0.002

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used is dividend payout ratio. 15th - 85th percentiles of the transition variable are 0 - 0.044 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 10: Firm Investment and Heterogeneous Adjustment Speeds

Panel A – Partial Adjustment Model of Leverage
Transition Variable: Firm Investment

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.572***	0.336***	0.492***	0.294***	0.510***	0.317***
	(0.051)	(0.043)	(0.030)	(0.062)	(0.035)	(0.054)
Threshold (Percentile)	-0.005(40)		0.110(72)		0.069(64)	
Number of Observations	2,158	3,231	3,882	1,507	3,450	1,939
Wald Test	248.64***		380.18***		345.55***	
AR(2) Test	-1.40[0.11]		-1.45[0.15]		-1.56[0.12]	
Sargan Test	-		57.91[0.03]		90.88[0.00]	

Panel B – Firm Characteristics in Each Regime

Firm Characteristics	Low	High	Low	High	Low	High
Leverage	0.249	0.195	0.243	0.149	0.247	0.162
Age	21.580	21.002	22.642	17.289	22.691	18.397
Tangibility	0.279	0.330	0.322	0.268	0.318	0.289
Profitability	-0.048	0.033	-0.004	0.004	-0.011	0.017
Growth	1.753	2.107	1.742	2.556	1.722	2.412
Size	10.864	11.644	11.338	11.214	11.274	11.368
Dividend Payout Ratio	0.020	0.025	0.023	0.023	0.023	0.024
Investment	-0.304	0.268	-0.160	0.533	-0.188	0.433
Cash Flow	0.015	0.084	0.052	0.059	0.046	0.071
Debt Capacity	1.957	1.490	1.927	3.278	2.033	2.763
Deviation	0.019	0.001	0.015	-0.008	0.016	-0.005
Absolute Deviation	0.086	0.067	0.078	0.068	0.080	0.067
Absolute Deviation Ratio	0.617	0.580	0.576	0.654	0.554	0.679
Financing Deficit	-0.015	0.044	0.000	0.069	-0.003	0.061
Net Debt Issued	-0.033	0.015	-0.016	0.022	-0.019	0.020
Net Equity Issued	0.037	0.049	0.030	0.083	0.030	0.070

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used is firm investment. 15th - 85th percentiles of the transition variable are -0.135 - 0.235 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 11: Growth Opportunities and Heterogeneous Adjustment Speeds

Panel A – Partial Adjustment Model of Leverage
Transition Variable: Growth Opportunities

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.536***	0.324***	0.455***	0.275***	0.438***	0.375***
	(0.043)	(0.049)	(0.028)	(0.073)	(0.031)	(0.094)
Threshold (Percentile)	1.381(51)		2.474(80)		2.642(82)	
Number of Observations	2750	2639	4,312	1,077	4,419	970
Wald Test	254.57***		340.83***		298.87***	
AR(2) Test	-1.02[0.31]		-1.23[0.22]		-1.15[0.21]	
Sargan Test	-		61.12[0.02]		96.69[0.00]	

Panel B – Firm Characteristics in Each Regime

Firm Characteristics	Low	High	Low	High	Low	High
Leverage	0.301	0.115	0.253	0.059	0.249	0.056
Age	23.271	18.713	22.287	16.442	22.189	16.313
Tangibility	0.353	0.251	0.328	0.217	0.325	0.218
Profitability	-0.001	-0.003	0.014	-0.077	0.013	-0.081
Growth	1.000	3.154	1.254	5.208	1.281	5.503
Size	11.385	11.206	11.458	10.597	11.454	10.526
Dividend Payout Ratio	0.018	0.029	0.021	0.032	0.021	0.033
Investment	-0.026	0.078	0.004	0.092	0.006	0.093
Cash Flow	0.050	0.059	0.066	-0.003	0.065	-0.006
Debt Capacity	1.693	1.693	2.312	2.118	2.295	2.185
Deviation	0.032	-0.020	0.015	-0.019	0.014	-0.016
Absolute Deviation	0.089	0.058	0.079	0.058	0.079	0.057
Absolute Deviation Ratio	0.481	0.740	0.485	1.111	0.500	1.101
Financing Deficit	0.003	0.038	0.013	0.040	0.015	0.036
Net Debt Issued	-0.013	0.003	-0.007	0.001	-0.007	0.001
Net Equity Issued	0.012	0.083	0.022	0.144	0.024	0.147

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used is growth opportunities. 15th - 85th percentiles of the transition variable are 0.885 - 2.932 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 12: Firm Size and Heterogeneous Adjustment Speeds

Panel A – Partial Adjustment Model of Leverage
Transition Variable: Firm Size

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.423***	0.538***	0.535***	0.391***	0.544***	0.402***
	(0.037)	(0.066)	(0.043)	(0.031)	(0.048)	(0.033)
Threshold (Percentile)	12.965(80)		10.041(31)		9.888(28)	
Number of Observations	4,312	1,077	1,671	3,718	1,509	3,880
Wald Test	254.41***		401.49***		375.26***	
AR(2) Test	-1.42[0.16]		-1.17[0.29]		-1.15[0.25]	
Sargan Test	-		55.12[0.06]		90.62[0.00]	

Panel B – Firm Characteristics in Each Regime

Firm Characteristics	Low	High	Low	High	Low	High
Leverage	0.202	0.281	0.160	0.242	0.157	0.240
Age	19.129	28.979	15.861	23.411	15.626	23.197
Tangibility	0.298	0.344	0.257	0.329	0.247	0.329
Profitability	-0.024	0.079	-0.140	0.053	-0.155	0.051
Growth	2.023	1.702	2.517	1.728	2.594	1.732
Size	10.470	14.344	8.926	12.258	8.809	12.168
Dividend Payout Ratio	0.022	0.028	0.015	0.026	0.014	0.026
Investment	0.012	0.046	-0.047	0.047	-0.060	0.047
Cash Flow	0.035	0.123	-0.072	0.104	-0.086	0.103
Debt Capacity	1.576	2.116	2.868	2.041	3.066	2.005
Deviation	0.006	0.020	-0.002	0.013	-0.003	0.013
Absolute Deviation	0.078	0.065	0.080	0.073	0.082	0.073
Absolute Deviation Ratio	0.661	0.360	0.901	0.474	0.930	0.481
Financing Deficit	0.021	0.006	0.037	0.011	0.038	0.011
Net Debt Issued	-0.008	0.004	-0.016	-0.002	-0.015	-0.003
Net Equity Issued	0.054	0.005	0.101	0.021	0.106	0.022

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used is firm size. 15th - 85th percentiles of the transition variable are 9.105 - 13.446 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 13: Stock Price Changes and Heterogeneous Adjustment Speeds

Panel A – Partial Adjustment Model of Leverage
Transition Variable: Stock Price Changes

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.579***	0.380***	0.524***	0.374***	0.502***	0.368***
	(0.070)	(0.042)	(0.044)	(0.038)	(0.038)	(0.044)
Threshold (Percentile)	-0.085(22)		-0.052(31)		-0.001(52)	
Number of Observations	979	4,410	1,379	4,010	2,313	3,076
Wald Test	250.18***		357.58***		344.24***	
AR(2) Test	-1.07[0.29]		-1.15[0.25]		-1.07[0.28]	
Sargan Test	-		58.85[0.02]		104.95[0.00]	

Panel B – Firm Characteristics in Each Regime

Firm Characteristics	Low	High	Low	High	Low	High
Leverage	0.267	0.204	0.269	0.194	0.254	0.179
Age	17.995	22.259	19.116	22.290	20.700	21.880
Tangibility	0.283	0.316	0.296	0.314	0.313	0.303
Profitability	-0.169	0.050	-0.121	0.056	-0.051	0.054
Growth	1.741	2.019	1.751	2.052	1.729	2.209
Size	10.371	11.594	10.641	11.628	11.076	11.567
Dividend Payout Ratio	0.012	0.026	0.016	0.027	0.020	0.026
Investment	-0.097	0.056	-0.069	0.063	-0.026	0.072
Cash Flow	-0.091	0.099	-0.050	0.105	0.013	0.101
Debt Capacity	2.002	1.597	1.906	1.589	1.759	1.618
Deviation	0.040	-0.001	0.039	-0.006	0.029	-0.015
Absolute Deviation	0.106	0.066	0.100	0.063	0.086	0.063
Absolute Deviation Ratio	0.707	0.562	0.644	0.573	0.585	0.608
Financing Deficit	0.027	0.016	0.025	0.015	0.017	0.019
Net Debt Issued	-0.023	-0.001	-0.017	0.000	-0.011	0.000
Net Equity Issued	0.064	0.037	0.055	0.038	0.040	0.047

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used is annual changes in stock prices. 15th - 85th percentiles of the transition variable are -0.126 - 0.088 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.

Table 14: Heterogeneous Adjustment Speeds and other Considerations

Panel A – Partial Adjustment Model of Leverage
Transition Variable: Financing Deficit

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.634***	0.384***	0.394***	0.482***	0.400***	0.507***
	(0.079)	(0.038)	(0.042)	(0.038)	(0.040)	(0.040)
Threshold (Percentile)	-0.051(15)		0.001(50)		0.001(50)	
Number of Observations	811	4,578	2,701	2,688	2,701	2,688
Wald Test	245.55***		371.56***		374.53***	
AR(2) Test	-1.40[0.16]		-1.23[0.22]		-1.23[0.22]	
Sargan Test	-		61.42[0.02]		91.42[0.00]	

Panel B – Partial Adjustment Model of Leverage
Transition Variable: Z-score (Bankruptcy Risk)

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.478***	0.385***	0.438***	0.437***	0.510***	0.368***
	(0.044)	(0.048)	(0.029)	(0.072)	(0.042)	(0.042)
Threshold (Percentile)	0.182(44)		4.524(78)		0.182(44)	
Number of Observations	2,372	3,017	3,881	1,508	2,372	3,017
Wald Test	242.60***		382.30***		349.89***	
AR(2) Test	-1.27[0.20]		-1.22[0.22]		-1.22[0.22]	
Sargan Test	-		58.77[0.02]		90.16[0.00]	

Panel C – Partial Adjustment Model of Leverage
Transition Variable: Relative Leverage (Under- and Over-Leveraged)

	AH-IV		GMM		SYSGMM	
	Low	High	Low	High	Low	High
Adjustment Speed	0.333***	0.574***	0.211***	0.601***	0.289***	0.630***
	(0.049)	(0.064)	(0.056)	(0.036)	(0.048)	(0.041)
Threshold (Percentile)	0.075(84)		-0.080(19)		0.017(64)	
Number of Observations	3,807	1,582	861	4,528	2,900	2,489
Wald Test	243.16***		430.17***		471.60***	
AR(2) Test	-1.33[0.18]		-1.19[0.22]		-1.21[0.23]	
Sargan Test	-		59.08[0.02]		95.92[0.00]	

Notes: This table presents the results for the dynamic threshold model based on equation (4). The transition variable used in Panel A is financing deficit. 15th - 85th percentiles of the transition variable are -0.051 - 0.116 respectively. The transition variable used in Panel B is the z-score. 15th - 85th percentiles of the transition variable are -6.172-8.314 respectively. The transition variable used in Panel C is the distance between leverage and target leverage. 15th - 85th percentiles of the transition variable are -0.095 - 0.080 respectively. GMM and SYSGMM are estimated by two-step estimation respectively. All models are estimated in first differences and include time dummies. Wald test is a test for joint significance of the estimated coefficients under the null of no relationship, asymptotically dstributed as χ^2 distribution. AR(2) is a test for second-order serial correlation, asymptotically distributed as N(0,1) under the null of no second-order serial correlation, respectively; and Sargan test is a test for over-identifying restrictions under the null of valid instruments, asymptotically distributed χ^2 distribution. The figures in $(\cdot)$ indicate the standard errors of coefficients and those in $[\cdot]$ indicate the p-value of the test statistic. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. See Table 1 for the proxies for the variables.