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Asymmetries in the capital structure speed of adjustment: The idiosyncratic case of the maritime industry

Cogent Economics & Finance

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Suggested Citation: Chasiotis, Ioannis; Konstantios, Dimitrios; Naoum, Vassilios-Christos (2022) : Asymmetries in the capital structure speed of adjustment: The idiosyncratic case of the maritime industry, Cogent Economics & Finance, ISSN 2332-2039, Taylor & Francis, Abingdon, Vol. 10, Iss. 1, pp. 1-12,

https://doi.org/10.1080/23322039.2022.2066764

This Version is available at: https://hdl.handle.net/10419/303635

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Cogent Economics & Finance

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/oaef20

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To cite this article: Ioannis Chasiotis, Dimitrios Konstantios & Vassilios-Christos Naoum (2022) Asymmetries in the capital structure speed of adjustment: The idiosyncratic case of the maritime industry, Cogent Economics & Finance, 10:1, 2066764, DOI: 10.1080/23322039.2022.2066764

To link to this article: https://doi.org/10.1080/23322039.2022.2066764

9

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Published online: 27 Apr 2022.

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Received: 11 October 2021 Accepted: 09 April 2022

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Reviewing editor: David McMillan, University of Stirling, Stirling, United Kingdom

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FINANCIAL ECONOMICS | LETTER

Asymmetries in the capital structure speed of adjustment: The idiosyncratic case of the maritime industry

Ioannis Chasiotis¹, Dimitrios Konstantios^{2*} and Vassilios-Christos Naoum²

Abstract: This study investigates asymmetries in the capital structure speed of adjustment in the case of a capital-intensive industry. Employing a sample of globally listed maritime, manufacturing and services firms between 1995 and 2020, we estimate a regime-switching partial adjustment model, to test whether the capital structure speed of adjustment depends on a firm's positioning relative to the target. After accounting for the fractional, bounded nature of leverage ratios using a DPF estimator we document that maritime firms exhibit a higher (lower) speed of adjustment when they lie below (above) their target. Our empirical findings suggest that this asymmetric behavior holds across industries but is more profound in maritime firms emphasizing this industry's particularity.

Subjects: Corporate Finance; Transport Industries; Shipping Industries

Keywords: capital structure; speed of adjustment; trade-off theory; maritime industry; service industry; manufacturing industry JEL classification: G32

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PUBLIC INTEREST STATEMENT

In this study, we focus on the financing decision, i.e., how much debt to take, of maritime firms. We test the validity of the Trade-Off theory which suggests that firms reach an optimal capital structure by balancing the benefits of debt against its disadvantages. The benefit of debt results from the associated interest payments which reduce taxable income and consequently the amount of taxes due; the disadvantage of debt stems from increased costs of financial distress (i.e., higher cost of capital). We find that maritime firms do move towards a target debt ratio although at a more moderate pace than firms in the services and manufacturing sectors. Our findings improve our understanding of financial decisions of maritime companies and highlight their distinctiveness, specifically, i) the absence tax advantage of debt is trivial due to sector-specific tax regimes and ii) the comparatively higher amount of debt of maritime firms that impedes their ability to adjust to back to the target debt ratio when deviating from above.

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1. Introduction

The extant empirical and theoretical research on capital structure has flourished upon the economic foundation set by Modialiani and Miller (1958). Their famous "irrelevance theorem" has brought under the spotlight the market frictions that render the capital structure decision value-relevant. One of the most prominent capital structure theories, the trade-off theory, suggests that firms balance the benefits of debt against its disadvantages. Increased leverage can benefit firms due to the resulting tax shield or the mitigation of agency costs of free cash flows. However, increased leverage can also magnify financial distress costs, agency costs of debt and hamper financial flexibility as borrowing capacity becomes exhausted. Thus, trade-off theory implies that firms have an optimal target leverage where firm value is maximized. A testable hypothesis regarding the latter is that if firms deviate from their target due to micro or macro-level leverage shocks, they are expected to revert to the target eventually. The relevant empirical research which explores the so-called capital structure speed of adjustment (SOA) provides noticeable empirical support to the trade-off theory. Specifically, several studies on national and international samples document a positive and economically significant SOA suggesting that firms do adjust back to target leverage (Drobetz et al. 2015; Alnori & Algahtani, 2019; An et al., 2021; Elsas & Florysiak, 2015; Kannadhasan et al., 2018; Öztekin & Flannery, 2012; Vo et al., 2022). Moreover, the aforementioned studies document considerable heterogeneity in the SOA between countries with diverse institutional and legal characteristics and market efficiency. Moreover, a number of studies focus on, asymmetries in the speed of adjustment depending on whether the firm reverts to its target from a position above or below its optimal target, have been understudied. Such insight would be valuable in drawing an integrated framework of the dynamics of capital structure.

In the current study, we explore SOA asymmetries concentrating on the maritime industry motivated by its significance and distinct characteristics. The maritime sector plays a pivotal role in facilitating global trade, is highly pro-cyclical while exhibiting high leverage and asset risk, characteristics which often lead to divergent financial decisions (Ahrends et al., 2018; Drobetz et al., 2013). Moreover, it is common for maritime firms to pay taxes according to their tonnage¹ (tonnage tax regimes) rather than paying tax on accounting profits. Additionally, maritime firms enjoy sectorspecific tax incentives and favorable tax regimes that lead to a trivial effective tax rate for maritime firms. Therefore, the tax-shield motive which plays a central role in the Trade-Off Theory (S. Myers, 1984) seems irrelevant for maritime firms. Accordingly, we hypothesize that due to the absence of a tax shield motive, ceteris paribus, maritime firms are expected to face lower costs of deviating below their target and thus approach their target at a slower pace than firms in other industries. Moreover, the highly levered, financially constrained risk profile of maritime firms may lead to both significant higher cost of adjustment (thus lowering the SOA from a position above optimal leverage) and higher costs of financial distress (thus increasing the SOA from a position above optimal leverage). Considering, the discussion in this paragraph in this study we aim to answer the following empirical research question. Does the SOA of maritime firms depend on their position relative to their target and in this respect are there any significant differences vis-à-vis other industries? There is a limited number of studies that focus on capital structure dynamics in the maritime sector, however these do not focus on SOA asymmetries and sectoral differences (see, Drobetz et al. 2015) or focus solely on a single country sample of maritime companies (see Guo et al. 2020).

To address our research objective, we use a regime-switching approach motivated by Apergis (2021) and Drobetz et al. (2015). Specifically, we employ a regime-switching partial adjustment model that allows the SOA and the effect of target leverage determinants to differ depending on the firm's positioning relative to the target. Such an approach suits the analysis of divergent behavior between two different states. In our case, we are interested in the divergent behavior of capital structure's speed of adjustment above and below target leverage. Moreover, to account for the mechanical mean reversion due to the bounded nature of leverage ratios we employ the Elsas and Florysiak (2015) DPF estimator. Also, we compare and contrast our findings from the

maritime industry to those obtained from the service and manufacturing industries. Section 2 presents our methodology, section 3 the data, section 4 discusses the results and section 5 concludes.

2. Methodology

Our research initiative investigates asymmetries in SOA between firms resulting from their positioning above and below the optimal leverage. To identify a firm's position against the target we proxy for a firm's optimal leverage using the fitted values from regressing leverage on well-known capital structure determinants drawn from the extant literature (Drobetz et al., 2013; Rajan & Zingales, 1995). Specifically, we estimate equation 1,

$$\mathsf{Lev}_{it} = \mathbf{a}_{\iota} + \beta_{it}\mathsf{Z}_{it} + \nu_t + \mu_i + \mathbf{e}_{\iota,t} \tag{1}$$

Where Lev is a firm's leverage ratio, α is a constant, Z is a vector of explanatory variables, ν_t , μ_i are time and year fixed effects, and e is the disturbance term. Our set of control variables includes *Profitability, Tangibility, FirmSize, GrowhtOpportunities, FreeCashFlows and Dividends*. Table A1 in the Appendix, provides variable descriptions. We included Profitability, as according to the Trade-Off theory profitable firms are expected to be more levered to shield their income from taxes. Nevertheless, more profitable firms are expected to be less levered according to the Trade-Off theory as they can fund investment internally and thus are less likely to access debt financing. *Tangibility* and *FirmSize* may lower the costs of financial distress and lead to higher leverage. *FreeCashFlows* control for the presence of agency costs and the corresponding demand for debt as a disciplinary mechanism. We also, control for *Dividends* and *Growth opportunities* since all else equal, dividend paying firms and firms with substantial growth opportunities are more likely to require debt financing to secure investment capital.

After estimating Equation 1,we compute the difference between the real leverage ratio and the optimal one $(Lev_{it} - \widehat{Lev}_{it})$. If the difference is positive (negative) the firm lies above (below) target leverage. In each state, we assume that the SOA and the target leverage determinants vary. To capture divergent behavior in capital structure dynamics above and below target, we adapt the regime-switching partial adjustment model utilized by Drobetz et al. (2015) who investigate heterogeneity in the speed of capital structure adjustment between different countries and macroeconomic states. Accordingly, we develop two separate models explain the adjustment process in each regime.

$$Lev_{it}^{A} = a_{1}Lev_{it-1}^{A} + \delta_{1}Z_{it}^{A} + \nu_{1t} + \mu_{1i} + \varepsilon_{it}^{A}$$

$$\tag{2}$$

$$Lev_{it}^{\mathcal{B}} = a_2 Lev_{it-1}^{\mathcal{B}} + \delta_2 Z_{it}^{\mathcal{B}} + \nu_{2t} + \mu_{2i} + \varepsilon_{it}^{\mathcal{B}}$$
(3)

Where A (B) stands for the regime where the firm lies above (below) its target leverage. We then construct the dummy variables D_A and D_B which take the value of 1 if the firm falls in the respective regime and 0 otherwise and rewrite equation 3 to.

$$Lev_{it} = D_A(a_1Lev_{it-1} + \delta_1Z_{it} + \nu_t + \nu_i + \varepsilon_{it}) + D_B(a_2Lev_{it-1} + \delta_1Z_{it} + \nu_t + \nu_{1i} + \varepsilon_{it})$$
(4)

where D_A and D_B are two regime dummy variables that equal to one if firm i is in the respective regime at time t and zero otherwise. Finally, we transform equation 4 to reach the empirically testable model below.

$$Lev_{it} = a_1 Lev_{it-1} + (a_2 - a_1) Lev_{it-1} D_B + \gamma_1 Z_{it} + (\gamma_2 - \gamma_1) Z_{it} Lev_{it-1} + \nu_i + \nu_i + \varepsilon_{it}$$
(5)

In equation 5, $\alpha_1 = 1 - \hat{\lambda}_A$, $\alpha_2 = 1 - \hat{\lambda}_B$ where $\lambda_A \lambda_B$ is the speed of adjustment (SOA) in each regime. We estimate Equation 5 using the DPF estimator constructed by Elsas and Florysiak (2010) which accounts for the problem of mechanical mean reversion in SOA studies. This issue arises from the fractional nature of leverage ratios which are bounded between zero and one.

$$Lev_{i=} \begin{cases} 0 & Lev'_{it} \leq 0 \\ Lev'_{it} & 0 < Lev_{it} < 1 \\ 1 & Lev'_{it} \geq 1 \end{cases}$$
(6)

where Lev'_{it} is the observed leverage, which is set to zero when it lower than zero, and set to one when it is above one. By doing so, the DPF estimator accounts for data errors considering that a normal leverage ratio lies between zero and one. The DPF estimator includes firm fixed effects to capture unobserved heterogeneity and time invariant characteristics.

$$Lev_{it} = (1 - \lambda)Lev_{it-1} + \delta_1 Z_{it} + \nu_t + \mu_i + \varepsilon_{it}$$
⁽⁷⁾

where,

$$\mu_i = \alpha_0 + \alpha_1 Le \mathbf{v}_{i0} + \mathsf{E}(Z_i) \alpha_2 + \alpha_i \tag{8}$$

The unobserved firm fixed effect μ_i depends on the mean of the firm-specific variables $E(Z_i)$ and on the leverage in the first period Lev_{i0} . Tobit estimation follows a maximum likelihood approach. The DPF estimator is unbiased considering distribution misspecifications regarding the fixed effect (Elsas and Florysiak, 2010).

3. Data

As the current study focuses in global maritime firms, we draw firm-level data from Compustat Global. Our sample includes the global maritime (two-digit sic: 40–49), manufacturing (two-digit sic: 20–39) and service industry (two-digit sic: 70–89) for the period 1995–2020.² For the maritime industry, we exclude the following firms i) shipyards and shipping ii) involved in passenger shipping, iii) drilling ships iv) supply vessels, and v) inland vessels. Table 1 provides descriptive statistics for our variables per industry while table A1, Appendix provides the variable definitions. Table 1 shows that the average maritime firm is larger, more levered, has more tangible assets and generates more profits and free cash flows when compared to its manufacturing and services counterparts.

4. Results

Table 2 presents the results from estimating the regime-switching partial adjustment model in equation 5. As a robustness test, we use two measures of leverage, namely book leverage and market leverage. Results support the economic relevance of the trade-off theory as the coefficient of the lagged leverage variable is positive across all industries suggesting that firms do have a target leverage ratio. This is in line with the Trade-Off Theory (S. Myers, 1984) and earlier empirical studies (Drobetz et al. 2015; Alnori & Alqahtani, 2019; An et al., 2021; Elsas & Florysiak, 2015; Kannadhasan et al., 2018; Öztekin & Flannery, 2012; Vo et al., 2022). Moreover, our findings show asymmetries between the two regimes (above and below target) for both SOA and the effect of target leverage determinants as the relevant interaction terms are statistically significant. For the three industries under consideration, we also compute the SOA in each regime and the half-life of a leverage shock (computed as $log(0,5)/log(1-\lambda)$ where λ is the respective SOA. We present these in Table 3.

Results show significant asymmetries in the SOA across industries. It appears that all firms approach target leverage faster from below than from above. This highlights a cost of adjustment differential since it would be less costly for the latter firm to issue debt and lever up than for the former to issue equity and un-lever. The maritime industry exhibits the slowest SOA across industries both from above and below. The slower approach from below is

between the maritime industry and the manufacturing and services industry respectively								
	(Mar	1) itime	(Manufo	2) acturing	(3)	Ser	(4) vices	(5)
	Mean	Median	Mean	Median	t-test	Mean	Median	t-test
Book Leverage	0.429	0.430	0.238	0.208	0.000	0.184	0.110	0.000
Market Leverage	0.452	0.461	0.287	0.214	0.000	0.195	0.095	0.000
Tangibility	0.602	0.652	0.314	0.296	0.000	0.213	0.098	0.000
Growth opportunities	0.109	0.035	0.140	0.056	0.447	0.229	0.079	0.462
ROA	0.079	0.080	0.066	0.083	0.000	0.046	0.077	0.000
Firm size	8.195	7.845	7.641	7.425	0.000	6.020	5.810	0.000
Dividends	0.010	0.000	0.023	0.000	0.444	0.011	0.00	0.420
Free cash flows	0.068	0.064	0.051	0.057	0.000	0.041	.0579	0.000
Observations	2,232	2,232	18,660	18,660		73,608	73,608	
Number of firms	155	155	1,450	1,450		6,840	6,840	

Table 1. Columns (1) (2) and (4) provide descriptive statistics per industry. Columns (3) and (5) provide t-tests for equal means

likely to reflect lower costs of deviation below the target due to the absence of tax shields. Moreover, a slower SOA from above suggests (see Table 1) that the aforementioned cost of adjustment is comparatively higher than the cost of deviation due to the high-leverage profile nature of maritime firms. This characteristic is likely to increase equity financing and thus impede readjustments to target leverage.

To provide further robustness in our findings, we need to ensure that maritime companies and non-maritime companies in service and manufacturing share similar characteristics. In our baseline model we control for a rich set of firm characteristics. Nevertheless, as a robustness test in our findings we match a maritime to a non-maritime firm based on firm size and year by employing the Coarsened Exact Matching (CEM) procedure (Iacus et al., 2012). Our estimates considering speed of adjustment (SOA), remain in the same direction as in the baseline model. These results are reported in Table 4.

Our findings support S.C. Myers (2001) who argues that capital structure theories are not general and thus testing them using large samples of dissimilar firms may mask considerable heterogeneity. Thus, stratification of firms into subsamples is a more suitable approach to test these theories.

5. Conclusion

This study explores the capital structure dynamics of globally listed maritime companies. First our results that maritime companies do move towards a target capital structure although at a more moderate pace than firms in the services and manufacturing sectors. Moreover, results showcase that maritime firms exhibit a higher (lower) speed of adjustment when they lie below (above) their target. This asymmetry is present in both the manufacturing and the services industry. Nevertheless, our findings are more profound in the maritime industry consistent with the notion that maritime firms face lower costs of deviating below the target due to their distinct taxation and the resulting absence of a tax shield. Moreover, although deviating above the target is likely to significantly raise costs of financial distress it appears that the corresponding cost of adjustment is comparatively higher due to the high-levered

Table 2. Results from e	stimating the regime-s	witching partial adjustn	nent model in eq. 5 usin	g the DPF estimator		
VARIABLES	Maritime	Services	Manufacturing	Maritime	Services	Manufacturing
Dependent variable:		Book leverage			Market leverage	
Leverage	0.514***	0.461***	0.501***	0.577***	0.513***	0.536***
	(0.019)	(0.004)	(0.002)	(0.023)	(0.005)	(0.002)
Tangibility	0.249***	0.183***	0.141***	0.155***	0.173***	0.149***
	(0.016)	(0.005)	(0.002)	(0:030)	(0.007)	(0.004)
Growth opportunities	0.001	-0.002***	0.000	0.022***	0.004***	0.011***
	(0.004)	(0.001)	(0.000)	(0.007)	(0.001)	(0.001)
Profitability	-0.233***	-0.122***	-0.157***	-0.255***	-0.107***	-0.151***
	(0.035)	(0.004)	(0.002)	(0.066)	(0.006)	(0.004)
Firm size	0.002	0.008***	0.004***	0.040***	0.037***	0.029***
	(0.002)	(0.001)	(0.000)	(0.004)	(0.001)	(0.001)
Dividends	-0.459***	-0.376***	-0.316***	-0.950***	-0.595***	-0.546***
	(0.118)	(0.027)	(0.012)	(0.239)	(0.039)	(0.023)
Free cash flows	-0.121***	0.063***	-0.060***	-0.008	-0.009	-0.013
	(0.044)	(0.005)	(0.003)	(0.085)	(0.008)	(6000)
Free cash flows x D _A	-0.104*	-0.387***	-0.309***	-0.399***	-0.233***	-0.262***
	(0.054)	(0.007)	(0.004)	(0.105)	(0.011)	(0.00)
Tangibility x D _A	-0.036**	0.025***	0.051***	-0.056*	0.005	-0.001
	(0.018)	(0.004)	(0.002)	(0.034)	(0.006)	(0.004)
Growth opportunities x D _A	-0.002	***600.0	0.008***	600.0	0.005***	0.001*
	(0.005)	(0.001)	(0.000)	(0.010)	(0.001)	(0.001)
Profitability x D _A	0.006	-0.101***	-0.096***	0.170*	-0.042***	0.038***
	(0.044)	(0.006)	(0.003)	(0.088)	(0.008)	(0.004)
Firm size x D _A	0.010***	0.018***	0.010***	0.010***	0.015***	0.012***
						(Continued)

Table 2. (Continued)						
VARIABLES	Maritime	Services	Manufacturing	Maritime	Services	Manufacturing
Dependent variable:		Book leverage			Market leverage	
	(0.001)	(0.000)	(000'0)	(0.002)	(0.000)	(0.000)
Tangibility x D _A	0.339*	1.009***	0.796***	0.262	0.535***	0.398***
	(0.183)	(0.036)	(0.018)	(0.363)	(0.053)	(0.024)
Leverage x D _A	0.115***	0.120***	0.09***	0.069*	0.052***	0.044***
	(0.022)	(0.005)	(0.002)	(0.038)	(0.006)	(0.003)
Constant	0.000	0.011***	0.014***	0.077**	0.021***	0.198
	(0.015)	(0.002)	(0.001)	(0.036)	(0.003)	(1.431)
Observations	2,232	18,660	73,608	2,232	18,660	73,608

Table 3. Results for the speed of adjustment (SOA) and half-life (in years) in each regime						ch regime
	Mari	time	Serv	vices	Manufo	icturing
Panel A	SOA	half-life	SOA	half-life	SOA	half-life
Regime A (above target leverage)	37,1%	1,5	41,9%	1,28	40,9%	1,32
Regime B (below target leverage)	48,6%	1	53,9%	0,90	49,9%	1
Difference	11,5%	0,5	12,0%	0,38	9,0%	0,32
Observations	2,2	.32	18,	660	73,	608
	Mari	time	Serv	vices	Manufo	icturing
Panel B	SOA	half-life	SOA	half-life	SOA	half-life
Regime A (above target leverage)	35,4%	1,58	43,5%	1,21	42,0%	1,27
Regime B (below target leverage)	42,3%	1,26	48,7%	1.04	46,4%	1,11
Difference	6,9%	0,32	5,2%	0,17	4,4%	0,16
Observations	2,2	.32	18,	660	73,	608

Table 4. Rob	ustness test,	counterparts-	matched sam	ple according	to firm size o	and year
	Mari	time	Serv	vices	Manufa	cturing
Panel A: Book Leverage	SOA	half-life	SOA	half-life	SOA	half-life
Regime A (above target leverage)	38,6%	1,42	43,5%	1,21	42,4%	1,26
Regime B (below target leverage)	47,2%	1,09	51,8%	0,95	50,1%	1,0
Difference	8,6%	0,34	8,3%	0,26	7,7%	0,26
	Mari	time	Serv	vices	Manufa	cturing
Panel B: Market leverage	SOA	half-life	SOA	half-life	SOA	half-life
Regime A (above target leverage)	36,5%	1,52	41,5%	1,29	40,0%	1,35
Regime B (below target leverage)	45,7%	1,13	49,6%	1,01	47,8%	1,06
Difference	9,2%	0,39	8,1%	0,28	7,8%	0,29
Observations	2,2	.32	2,2	232	2,2	32

and financial constraint nature of maritime firms. This study provides further insight into the dynamics of capital structure. It contributes to the literature by highlighting sectoral asymmetries in the capital structure speed of adjustment which emphasize the distinctiveness of the maritime industry. From a research perspective, our findings support the contention of S. C. Myers (2001) who warrants caution on the use of large cross-industry samples which estimate a single coefficient. Such estimations may not be as informative since they may conceal divergent behavior. The policy implication that stems from the results is that policy makers and financiers need to acknowledge that capital structure dynamics are not stable over time or across industries. Therefore, it may be the case that government policies lending policies of financiers may need to vary across industries as well, to match the distinct traits of each sector. We acknowledge that our results due to research design are applicable to the universe of maritime listed firms. An interesting avenue for further research would be to investigate, compare and contrast the capital structure dynamics of private versus listed maritime firms.

Funding

The authors received no direct funding for this research.

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Citation information

Cite this article as: Asymmetries in the capital structure speed of adjustment: The idiosyncratic case of the maritime industry, Ioannis Chasiotis, Dimitrios Konstantios & Vassilios-Christos Naoum, *Cogent Economics & Finance* (2022), 10: 2066764.

Notes

- 1. See PricewaterhouseCoopers (2009) for a comprehensive guide on maritime tax regimes.
- 2. The Compustat Global Database starts in 1987, however a lot of observations are missing before 1995.
- 3. Author's calculations using the Compustat Global securities. Market value of equity has been calculated as the stock price (year-end) multiplied by the number of common shares outstanding.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Table A1. Variable definitions					
Variables	Description	Compustat items			
Book Leverage	long term and current debt scaled by the book value of total assets	dllt,dlc, at			
Market Leverage	long term and current debt scaled by the sum of market value of equity ³ plus the book value of debt	dllt,dlc, lt			
Tangibility	net property, plant and equipment scaled by the book value of total assets	ppenc, at			
Growth opportunities	net sales growth, (sales _t —salest ₋₁)/sales _{t-1}	sale			
Profitability	EBITDA scaled by the book value of total assets	ebitda, at			
Firm size	natural logarithm of the book value of total assets	at			
Dividends	cash dividends to common to the book value of total assets	dvc			
Free cash flows	Free cash flows, following Richardson's (2006) framework are calculated as net operating cash flows minus expected investment minus investment required to maintain existing assets in place.				



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