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Nonlinear Debt Burden and Return on Capital Across Corporate Life Cycles and Institutional Regimes

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Abstract

This study examines the relationship between return on capital and corporate debt burden across corporate life-cycle stages and institutional regimes. The analysis uses an unbalanced global sample of 330,875 firm-year observations from 28,804 firms in 134 economies between 2000 and 2022, and includes high-dimensional fixed effects, dynamic lag specifications, and instrumental-variable robustness tests. The evidence indicates debt can enhance capital productivity when it serves to discipline managerial slack and to finance productive growth, but excessive debt brings debt overhang, liquidity pressure and operating fragility. The findings also suggest that sustainable debt capacity varies across life-cycle stages and that it is limited in emerging-market settings. The study contributes to the capital structure literature by combining trade-off theory, debt overhang, corporate life-cycle theory, and institutional finance into a unified debt-return framework, with implications for the design of covenants, corporate treasury policy, and macroprudential supervision.

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1. Introduction

One of the principal mechanisms that firms use to finance investment, smooth operating cash flows, and control managerial decision making is corporate debt. Capital structure research since the seminal work of Modigliani and Miller (1958) has demonstrated that leverage is economically relevant when frictions apply to the model, such as taxes, asymmetric information, agency conflicts, bankruptcy costs and creditor enforcement. However, in practice, it is insufficient to look at book leverage ratios to fully understand the debt effects on the firm's operating outcomes. Growing attention to Debt/EBITDA reflects its link to the cash-flow capacity of the firm. Accordingly, Debt/EBITDA is a better indicator of whether the firm can sustain its obligations while continuing to generate productive returns on investment.

Across the 2000-2022 period, the global corporate sector has experienced a series of shocks, such as credit-cycle expansions, the Global Financial Crisis, commodity-price volatility and the pandemic's adverse shock to operating cash flows. These shocks exacerbated the debt burden issue by showing that the operating outcomes could be quite different for firms of similar asset structures, depending on the maturity of their business model and the institutional

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characteristics of the debt refinancing environment. A debt multiple may enable a Growth firm to finance productive expansion, but may be costlier for a Mature firm with limited growth opportunities in Emerging Markets and Developing Economies where credit markets are shallow and the legal framework surrounding enforcement of debt is less predictable.

Prior research reports mixed results about the leverage-performance relationship. Some studies emphasize the disciplining effect of debt and document positive performance effects, such as Berger and Bonaccorsi di Patti (2006), Margaritis and Psillaki (2010), and Choi et al. (2025), while others link leverage to underinvestment, financial distress and poorer operating performance, as in Myers (1977), Opler and Titman (1994), Rajan and Zingales (1995), Graham et al. (2015), Kalemli-Özcan et al. (2022), Acharya et al. (2025), Banerjee et al. (2025), and Feldhütter & Schaefer (2023). This reflects methodological inconsistency. Despite the trade-off theory and debt overhang theory, suggesting that the debt effects on a firm's marginal impact should vary as the firm's financing discipline approaches a severe debt burden, much of the evidence treats the impact of leverage as linear.

A second gap concerns heterogeneity. Research on the corporate life cycle reveals that the growth opportunities, asset tangibility, cash-flow stability and financing requirements vary among firms across stages of their life cycle: Introduction, Growth, Mature, Shakeout and Decline (Dickinson, 2011; Habib & Hasan, 2019; Hasan et al., 2023). Banking-sector structure and refinancing depth, judicial efficiency, and creditor rights also influence the impact of financial contracts on real investment, as indicated by institutional finance research (La Porta et al., 1997, 1998; Djankov et al., 2007, 2008; Pelizzon et al., 2024; Saunders et al., 2025). However, these two aspects of debt burden have rarely been combined in a single, nonlinear framework in the debt burden literature. To address this gap, this study seeks to answer the following three research questions: Is the relationship between Debt/EBITDA and Return on Capital nonlinear? Do debt-return turning points differ across life-cycle stages of corporations? What are the implications for the Sustainable Debt Frontier between Advanced Economies and Emerging Markets across institutional environments? Recent firm-level evidence also links life-cycle position to innovation-emission outcomes and restructuring behavior (Ashraf et al., 2025; Ghazali et al., 2026b).

This study uses a global panel of 330,875 firm-year observations of 28,804 listed non-financial corporations in 134 economies from 2000 to 2022 to answer these questions. ROC serves as the primary measure of operating capital productivity and Debt/EBITDA serves as a measure of the cash-flow implications of debt. The empirical strategy involves high-dimensional firm and year fixed-effect estimates of nonlinear specifications, Dickinson's (2011) cash-flow classification, institutional subsample comparisons, dynamic lag models, and two-stage instrumental-variable tests. This design is aligned with prior work and follows an analytical sequence from motivation to model, heterogeneity, and contribution to corporate finance.

The evidence indicates that debt burden is nonlinear. While moderate debt is disciplining and productive along with the efficient use of capital, high Debt/EBITDA can generate debt overhang, liquidity pressure and poor capital productivity. The results also show that debt capacity is contingent. Growth firms can sustain their debt multiples longer and still perform well, while Mature firms reach their performance-maximizing tipping points sooner. The institutional environment also matters: Firms in Emerging Markets are subject to more

restrictive financing environments, as the translation of debt pressure into operating decisions is transmitted earlier due to weak creditor protection, shorter debt maturities, and rollover risk.

This study has four contributions. First, it reconciles conflicting results found by some leverage-performance studies by demonstrating that the debt-return relationship is not linear but the relationship can be positive, negative or non-existent. Second, it extends corporate life-cycle theory by showing that the debt capacity of the firm is not limited to industry or firm size, but varies as a function of the operating and financing characteristics of the firm. Third, it links the firm-level decisions on capital structure to the national institutional environment by demonstrating that the debt frontier is affected by weak financial and legal environments. Fourth, it provides an empirical framework for both designing covenants and conducting macroprudential monitoring by estimating turning points in Debt/EBITDA using fixed effects, interacted, and Delta-method inference.

The manuscript is organized as follows. The theoretical background is presented and the hypotheses are formulated in Section 2. The data, variables, theory and empirical approach are described in Section 3. The empirical results and the different economic mechanisms, life cycles, institutional differences and robustness tests are presented in Section 4. Section 5 concludes with policy implications, limitations and future research paths.

2. Theoretical Foundations and Hypotheses Development

2.1. Capital Structure Theory and Operating Performance

Capital structure theory can be used as a foundation for understanding the debt-performance effects. Trade-off theory suggests that a firm's debt policy must balance tax benefits and agency-disciplining benefits against expected distress and bankruptcy costs of debt (Kraus & Litzenberger, 1973; Myers, 1984). Debt constrains managerial discretion over the use of free cash flow and may induce managers to be more careful about capital allocation at moderate leverage (Jensen & Meckling, 1976; Jensen, 1986; Stulz, 1990). An alternative explanation is the pecking order theory which focuses on the information asymmetry and preference for financing in the following order: internal funds, safe debt, risky debt, and equity (Myers & Majluf, 1984).

These theories suggest that the determinants of the observed level of debt loads may reflect deliberate optimization and the build-up of financing constraints. Debt can help capital productivity when used to fund profitable investment or when used to discipline cash flow, but can reduce operating performance when it takes up management's attention and limits investment. The empirical question is not whether debt is beneficial or harmful, per se, but whether the marginal effect of debt varies with increases in cash-flow burden.

2.2. Nonlinear Debt Burden and Debt Overhang

The mechanism through which high leverage can reduce operating returns is explained by debt overhang theory. If debt is sufficiently high, Myers (1977) suggests that shareholders might not invest in positive NPV projects because some of the returns will be captured by debtholders. Operationally, it can lead to maintenance delays, reduce innovation, postponement of capital upgrading, or project abandonment. These costs are further

exacerbated by financial distress because customers, suppliers, employees and creditors react to their perceptions of a fragile firm (Altman, 1968; Titman, 1984; Opler & Titman, 1994; Davis & Gondhi, 2024; Voss, 2025).

A nonlinear association between Debt/EBITDA and Return on Capital is therefore expected. Debt may be linked to discipline, tax benefits and productive growth at low and moderate levels. Beyond a threshold of debt, underinvestment, covenant pressure, refinancing risk and operational disruption may arise. This leads to Hypothesis 1:

Hypothesis 1. The relationship between corporate debt burden, measured by Debt/EBITDA, and Return on Capital is nonlinear. Moderate debt is associated with higher capital productivity, whereas excessive debt burden is associated with lower capital productivity once debt overhang and financial distress costs dominate.

2.3. Corporate Life Cycle and Debt Capacity

The debt-return frontier should differ by the life-cycle stage of the corporation, under life-cycle theory. Based on the characteristics of operating, investing and financing cash flows, Dickinson's (2011) cash-flow classification classifies firms into five life-cycle stages: Introduction, Growth, Mature, Shakeout, and Decline. High investment opportunities, high operating scale, and expanding markets are characteristics of growth firms. For these firms, debt may be used to build productive capacity and expand the market before cash-flow constraints bind. By contrast, mature firms have fewer high-return investment opportunities, but more stable operations. Accordingly, high debt in Mature firms might be used to finance payouts, defensive acquisitions or restructuring, instead of productive expansion.

Shakeout firms are at even greater risk due to declining demand, weak cash flows and obsolescence. These phases are often characterized by high Debt/EBITDA that may be a result of distress borrowing or EBITDA deterioration. The life-cycle theory thus suggests that debt turning points will not be universal and vary across stages. This leads to the second hypothesis:

Hypothesis 2. Corporate life-cycle stage moderates the debt-return relationship. Growth firms can sustain higher Debt/EBITDA before Return on Capital deteriorates, whereas Mature, Shakeout, and Decline firms face lower sustainable debt capacity because growth opportunities and operating flexibility are more limited.

2.4. Institutional Environment and the Emerging Market Penalty

Institutional frameworks influence the way debt contracts are enforced and refinanced. Financial contracting and real investment reflect law-and-finance conditions, creditor protection, legal enforcement, bankruptcy procedures, and capital market depth (La Porta et al., 1997, 1998; Djankov et al., 2007, 2008). Deeper bond markets, bankruptcy regimes that are more predictable and stronger accounting transparency can enable advanced-economy firms to renegotiate or refinance their debts without disrupting operations. In Emerging Markets and Developing Economies debt pressure is costlier due to institutional voids, short debt maturities, volatile currencies, and concentrated banking systems (Khanna & Palepu, 2000; Custodio et al., 2013; Kalemli-Özcan et al., 2022; Binfarè et al., 2025). Recent evidence on natural-resource wealth and corporate innovation further shows that governance and

managerial discipline condition how resource rents affect R&D decisions (Ghazali et al., 2026a).

Such institutional differences mean that the same Debt/EBITDA multiple can have different operating consequences across countries. If refinancing channels are weak, then creditors can restrict working capital, or suppliers can shorten payment terms, or managers can preserve liquidity by reducing productive investment. Therefore, emerging-market companies may experience deterioration in their operating performance if they have lower levels of debt than counterpart firms in their advanced-country segment. This leads to the third hypothesis:

Hypothesis 3. National institutional development moderates the debt-return relationship. Firms in Emerging Markets and Developing Economies reach lower sustainable Debt/EBITDA turning points than firms in Advanced Economies because weaker financial and legal institutions transmit debt pressure more directly into operating fragility.

2.5. Research Gap

Prior studies on capital structure offer valuable evidence on leverage, debt overhang, financial distress, and corporate performance, but leave three related gaps. First, the empirical literature still focuses on book leverage or debt ratios, and gives less attention to Debt/EBITDA as a debt-burden measure based on cash flows (Binfarè et al., 2025; Gholami & Elnahas, 2025), used by lenders, rating agencies, and treasurers. Second, prior studies often overlook the fact that theory suggests that debt may improve capital productivity at moderate levels but may impair productivity through "repayment pressure," "refinancing risk," and "underinvestment incentives". Third, the literature does not examine whether this nonlinear debt-return frontier varies jointly across life-cycle stages and institutional regimes. This study fills these gaps by estimating turning points of Debt/EBITDA for a large global panel and by examining how sustainable debt is affected by life-cycle position and institutional development across countries.

3. Methodology

The empirical design follows directly from the theoretical framework: debt burden is expected to have a first-order and a second-order effect on Return on Capital, while life-cycle stage and institutional environment are expected to shift the location of the turning point. This structure allows the study to test both the existence of a nonlinear debt-return frontier and the conditions under which that frontier changes.

3.1. Data

To test the hypotheses, we construct a large international sample of non-financial corporations from 134 economies spanning 2000 to 2022. The initial universe includes all publicly listed firms on stock exchanges and large private firms that report their financial statements in a standardized manner in global databases. In line with the standard practice in empirical corporate finance (Rajan & Zingales, 1995; Bates et al., 2009; Graham et al., 2015), we apply several data filters:

First, we exclude financial institutions (SIC 6000-6999), as they have very different balance sheet structures, statutory capital adequacy requirements, and access to central bank liquidity

from commercial enterprises. Second, regulated utilities (SIC 4900–4999) are excluded because their capital structure and operating returns are determined by administrative rate-of-return mechanisms, instead of competitive market forces. Third, we require firms to have positive total assets, non-negative book equity, and valid annual filings with total debt, EBITDA, operating income and net capital employed.

All continuous variables are winsorized at the 1st and 99th percentiles of their pooled distributions to mitigate the impact of reporting errors, coding anomalies and hyperinflationary outliers on the econometric estimates while avoiding the possibility of selection bias. This yields an unbalanced research panel of 330,875 firm-year observations of 28,804 unique enterprises in 134 economies. Table 1 shows broad sample diversity, with Advanced Economies accounting for 182,737 firm-years (55.2%) and Emerging Markets accounting for 148,138 firm-years (44.8%).

3.2. Theoretical Framework and Empirical Modeling

Primary Dependent Variable: Our primary metric of enterprise operating capital productivity is Return on Capital (ROC, %), defined as Earnings Before Interest and Taxes (EBIT) divided by Total Capital Employed, where Total Capital Employed equals total debt plus book value of equity minus cash. In robustness tests, we also evaluate Return on Invested Capital (ROIC Alt, %) and classical Return on Assets (ROA, %).

$$\mathrm{ROC}_{i,t} = [\mathrm{EBIT}_{i,t} / (\text{Total Debt}_{i,t-1} + \mathrm{Equity}_{i,t-1} - \mathrm{Cash}_{i,t-1})] \times 100 \quad (1)$$

Primary Explanatory Variable: The primary metric of corporate debt burden is the Debt-to-EBITDA multiple (Debt/EBITDA, x), defined as total interest-bearing debt divided by Earnings Before Interest, Taxes, Depreciation, and Amortization. To model the hypothesized inverted U-shaped relationship, we also construct the squared Debt/EBITDA term.

$$\mathrm{Debt/EBITDA}_{i,t} = \text{Total Debt}_{i,t} / \mathrm{EBITDA}_{i,t} \quad (2)$$

$$\mathrm{Debt/EBITDA\ Sq}_{i,t} = (\mathrm{Debt/EBITDA}_{i,t})^2 \quad (3)$$

Vector of Control Variables: To isolate the independent effect of debt burden from confounding firm characteristics, our models incorporate a comprehensive set of corporate control variables. Firm Size (Size) is measured as the natural logarithm of total assets in constant US dollars, controlling for economies of scale and institutional borrowing advantages. Cash Holdings (Cash) is the ratio of cash and marketable securities to total assets, capturing liquid precautionary slack (Bates et al., 2009). Capital Expenditures (CapEx) is the ratio of capital expenditures to total assets, controlling for physical asset expansion intensity. Operating Profitability (ROA, %) is return on assets, controlling for current baseline operating performance. Sales Growth (Growth, %) is the annual percentage change in revenue, proxying for market demand and short-term expansion opportunities. Asset Tangibility (Tang, %) is the ratio of net property, plant, and equipment to total assets, measuring pledgeable collateral capacity (Almeida & Campello, 2007). Firm Age (Age) is the number of years since the firm's founding, controlling for organizational maturation.

3.2.1. Corporate Life-Cycle Operationalization

To test Hypothesis 2, we implement Dickinson's (2011) cash-flow pattern methodology to classify firms into five distinct life-cycle stages based on the sign combinations of operating (CFO), investing (CFI), and financing (CFF) cash flows:

The baseline estimating equation and the associated performance-maximizing turning point are specified in Equations (4) and (6). The expected inverted U-shaped relationship requires $\beta_1 > 0$ and $\beta_2 < 0$ when the debt variable is scaled so that low leverage captures discipline and high leverage captures overhang.

1. Introduction (CFO < 0, CFI < 0, CFF > 0): Nascent enterprises establishing initial production scale, comprising 32,362 firm-year observations (9.8% of the sample).

2. Growth (CFO > 0, CFI < 0, CFF > 0): Rapidly expanding enterprises commercializing products and expanding market share, encompassing 92,341 observations (27.9%).

3. Mature (CFO > 0, CFI < 0, CFF < 0): Established market leaders generating strong operating cash flows and returning capital to investors, representing the largest cohort with 154,259 observations (46.6%).

4. Shakeout (CFO < 0, CFI > 0, CFF < 0 or CFO > 0, CFI > 0, CFF > 0): Inflection-stage firms facing volatile demand, comprising 6,249 observations (1.9%).

5. Decline (CFO < 0, CFI > 0, CFF >= 0 or CFF < 0): Structurally declining enterprises liquidating assets and servicing distressed debt, comprising 45,664 observations (13.8%).

3.3. Empirical Strategy

Our baseline econometric model evaluates the nonlinear response of Return on Capital to debt burden while controlling for unobserved time-invariant firm attributes and macroeconomic shocks:

$$\mathrm{ROC}_{i,t} = \alpha_0 + \beta_1 \mathrm{Debt/EBITDA}_{i,t} + \beta_2 (\mathrm{Debt/EBITDA}_{i,t})^2 + \gamma' X_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (4)$$

where i indexes the firm, t indexes the fiscal year, X_{i,t} represents the vector of control variables, mu_i denotes unobserved firm fixed effects, lambda_t denotes year fixed effects, and epsilon_{i,t} is the idiosyncratic error. Firm fixed effects absorb all time-invariant enterprise characteristicsincluding organizational culture, historical geographic advantages, managerial talent, and industry technological parametersguaranteeing that identification is achieved solely through within-firm time variation. Year fixed effects absorb global macroeconomic cycles, international interest rate shocks, and global inflation dynamics. Throughout all estimations, standard errors are clustered at the firm level (Petersen, 2009) to control for heteroskedasticity and arbitrary within-firm serial correlation.

To test life-cycle and institutional moderation, we estimate fully interacted models across life-cycle stages and economic groupings:

$$\mathrm{ROC}_{i,t} = \Sigma_k [\beta_{1,k} \mathrm{Debt/EBITDA}_{i,t} I(\mathrm{Stage}_k) + \beta_{2,k} (\mathrm{Debt/EBITDA}_{i,t})^2 I(\mathrm{Stage}_k)] + \gamma' X_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (5)$$

The optimal performance-maximizing debt turning point for each subgroup is derived analytically from Equation (6). To conduct statistical inference on these turning points and test pairwise differences across groups, we employ the nonlinear Delta method using Equation (7). This provides standard errors, z-statistics, 95% confidence intervals, and p-values for turning points and their pairwise cross-group differences (Table 8B).

$$\mathrm{Debt/EBITDA}^* = -\beta_1 / (2\beta_2) \quad (6)$$

$$\mathrm{Var}(\theta) = \nabla g(\beta)' \Sigma_\beta \nabla g(\beta), \text{ where } \nabla g(\beta) = [-1/(2\beta_2), \beta_1/(2\beta_2^2)]' \quad (7)$$

The results are discussed in a sequence that mirrors the hypotheses. The first set of estimates establishes the baseline nonlinear debt-return frontier, the second evaluates operating-margin

and scale heterogeneity, the third tests corporate life-cycle moderation, and the fourth examines institutional differences between advanced and emerging economies.

3.4. Identification Defenses

A central concern in capital structure studies is the potential endogeneity of debt burden. The Debt/EBITDA multiple could be artificially inflated due to negative operational shocks that lower EBITDA, while also reducing Return on Capital. Moreover, it is likely that unobserved time-varying managerial shocks may affect both debt acquisition and capital returns. To achieve causal identification, we conduct four econometric checks:

First, we estimate dynamic lagged models with all the explanatory variables lagged one period (i.e. t-1), thereby reducing the possibility of contemporaneous simultaneity between current profitability shocks and past debt levels.

Second, two-stage least squares (2SLS) instrumental variables (IV) estimation is used. Based on the identification approach of Almeida et al. (2004) and Kalemli-Özcan et al. (2022), we instrument debt burden and squared debt burden with the following instruments: (i) first- and second-order lagged debt multiples, which are correlated with past capital structure commitments and uncorrelated with the current idiosyncratic profitability shocks; and (ii) the country-industry-year mean debt multiples, excluding the focal firm, which are correlated with exogenous shifts in the supply of credit in the local credit market.

Third, leverage intensity is partitioned into three groups (< 2.0x, 2.0-5.0x and >= 5.0x) and piecewise linear splines are estimated to confirm that the performance deterioration occurs specifically at high leverage intensities.

Fourth, we re-estimate our models during the tranquil post-crisis period after the 2008 Global Financial Crisis (2011-2022) to ensure that our results do not reflect a distortion of the 2008 Global Financial Crisis.

4. Empirical Results and Their Discussion

4.1. Empirical Results

Table 1 reports the composition of the global research panel by economic tier and corporate life-cycle stage. The sample is broad enough to test whether the debt-return relation is general and not an effect attributable to a region, institutional setting, or a phase of firm life cycle. Most observations come from the Mature and Growth firms, followed by the Introduction and Shakeout firms, and then the Decline firms providing additional variation for distinguishing between organizational conditions with changes in debt capacity.

Table 1. Sample Composition Across Economic Tiers and Life-Cycle Stages

Life-Cycle Stage	Advanced Economies	Emerging Markets	Total Sample
Introduction	17,850	14,512	32,362
Growth	50,890	41,451	92,341
Mature	85,120	69,139	154,259
Shakeout	3,450	2,799	6,249

Decline	25,427	20,237	45,664
Total	182,737	148,138	330,875

Note. Global panel of non-financial corporations across 134 economies from 2000 to 2022. Corporate life-cycle stages are classified with the Dickinson (2011) cash-flow pattern methodology.

Figure 1 is introduced to show how debt burdens and capital returns evolved across the sample period. The pattern helps connect the study's nonlinear argument to macroeconomic episodes in which credit conditions, refinancing pressure, and operating returns moved together.

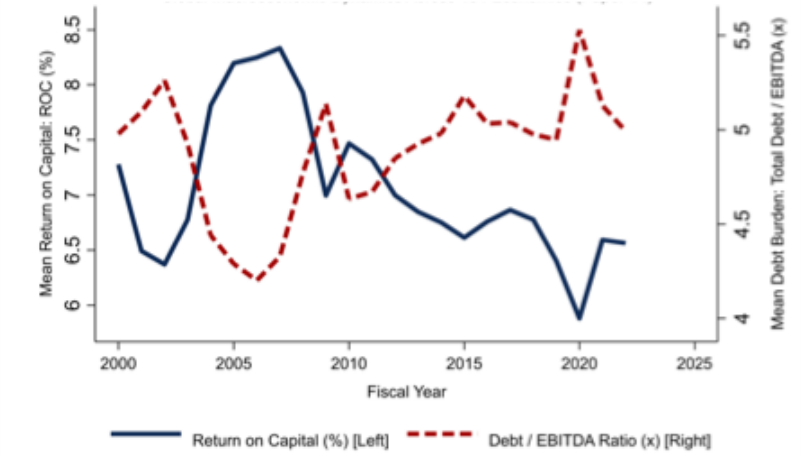

Figure 1: Longitudinal Trends in Corporate Debt Burden and Return on Capital (2000–2025)

Table 2 presents descriptive statistics. The Debt/EBITDA distribution indicates that the sample includes both conventionally levered firms and high-repayment-pressure firms. This variation is important because the study's argument relies on the observation of firms in the debt-burden distribution, rather than only around the average debt burden.

Table 2. Descriptive Statistics for Core Variables

Variable	Mean	Std. Dev.	P25	Median	P75	Min	Max
Return on Capital (%)	6.96	7.27	2.35	5.27	9.59	-5.33	39.36
Debt Burden: Debt / EBITDA (x)	4.92	8.77	0.90	2.42	5.14	0.01	63.53
Firm Size: Log(Assets)	12.38	2.10	10.98	12.32	13.75	7.33	17.58
Cash Holdings Ratio	0.11	0.11	0.03	0.08	0.16	0.00	0.56
CapEx Ratio	0.05	0.06	0.01	0.03	0.07	0.00	0.30
Return on Assets (%)	4.87	4.69	1.78	3.86	6.83	-3.38	23.82
Sales Growth Rate (%)	13.79	30.91	-1.54	7.86	22.25	-50.50	159.96

Asset Tangibility: PP&E / Assets (%)	31.72	23.14	12.90	27.82	46.18	0.23	93.34
Firm Age (Years)	33.84	27.48	14.00	26.00	46.00	1.00	138.00

Note. Continuous variables are winsorized at the 1st and 99th percentiles to mitigate outlier distortion.

Table 3 indicates that the pairwise correlations of explanatory variables are acceptable, thus limiting concerns regarding simple multicollinearity.

Table 3. Pearson Correlation Matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Return on Capital (%)	1.000								
(2) Debt Burden: Debt / EBITDA (x)	-0.367	1.000							
(3) Firm Size: Log(Assets)	-0.046	0.007	1.000						
(4) Cash Holdings Ratio	0.165	-0.145	-0.024	1.000					
(5) CapEx Ratio	0.121	-0.082	-0.033	-0.091	1.000				
(6) Return on Assets (%)	0.926	-0.391	-0.063	0.163	0.162	1.000			
(7) Sales Growth Rate (%)	0.242	-0.085	-0.058	0.029	0.110	0.253	1.000		
(8) Asset Tangibility: PP&E / Assets (%)	-0.145	0.053	0.029	-0.325	0.406	-0.093	-0.041	1.000	
(9) Firm Age (Years)	-0.067	-0.013	0.246	-0.093	-0.086	-0.088	-0.139	0.046	1.000

Note. Correlations are computed across the global panel. Values exceeding |0.01| are statistically significant at $p < 0.05$.

4.2. Baseline Estimations: Evidence of the Nonlinear Debt-Return Frontier

The baseline test of the nonlinear debt-return frontier is reported in Table 4. The results support the nonlinear association between Debt/EBITDA and Return on Capital in

progressively richer fixed-effect specifications. Notably, the estimates are not necessarily viewed as a universally positive or universally negative financing condition. Instead, debt's operating significance varies across the debt spectrum; moderate debt levels are correlated with capital discipline while high debt burdens are correlated with debt overhang, liquidity pressure and lower capital productivity.

This finding supports Hypothesis 1. The evidence reconciles previous mixed results in the leverage-performance literature by documenting that the sign and meaning of leverage is contingent on the firm's position on the debt frontier. The results further support the use of the Debt/EBITDA rather than book-leverage measures since it is the cash-flow strain of debt that becomes a constraint of operations.

Table 4. Baseline Regressions: Debt Burden and Return on Capital

Independent Variables	**(1) Pooled OLS**	**(2) Year FE**	**(3) Quad Year FE**	**(4) Ind & Year FE**	**(5) Firm FE**
Debt Burden: Debt / EBITDA (x)	-0.0046***	-0.0046***	-0.0463***	-0.0452***	-0.0099**
	(0.0010)	(0.0010)	(0.0032)	(0.0033)	(0.0029)
Debt / EBITDA Squared	—	—	0.0008***	0.0008***	0.0002***
			(0.0001)	(0.0001)	(0.0000)
Firm Size: Log(Assets)	0.0330***	0.0366***	0.0411***	0.0365***	-0.2481***
	(0.0065)	(0.0066)	(0.0066)	(0.0067)	(0.0184)
Cash Holdings Ratio	-0.2429*	-0.1319	-0.2966**	-0.3264**	-0.8094***
	(0.1127)	(0.1137)	(0.1141)	(0.1156)	(0.1168)
CapEx Ratio	-0.4584**	-0.6532***	-0.7541***	-0.8381***	-0.6607***
	(0.1568)	(0.1572)	(0.1567)	(0.1597)	(0.1284)
Return on Assets (%)	1.4158***	1.4146***	1.4034***	1.4060***	1.4342***
	(0.0042)	(0.0042)	(0.0045)	(0.0045)	(0.0039)
Sales Growth Rate (%)	0.0024***	0.0026***	0.0028***	0.0029***	0.0019***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)
Asset Tangibility (%)	-0.0191***	-0.0191***	-0.0188***	-0.0182***	-0.0086***
	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0009)
Firm Age (Years)	0.0039***	0.0039***	0.0037***	0.0035***	0.0586***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0129)

Constant	0.1598*	0.0791	0.2291**	0.2413*	1.8478***
	(0.0781)	(0.0805)	(0.0806)	(0.1033)	(0.3456)
Optimal Debt Turning Point (x)	—	—	—	29.3x	29.2x
Observations	307,920	307,920	307,920	307,904	307,920
R-squared	0.8611	0.8613	0.8616	0.8628	0.8638
F-statistic / Wald Chi2	27519.34	7630.85	7721.18	6252.93	7860.40
Firm Fixed Effects	No	No	No	No	Yes

*Note. Dependent variable is Return on Capital (ROC %). Standard errors clustered by firm appear in parentheses. * p < 0.05, ** p < 0.01, *** p < 0.001.*

Figure 2 visualizes the central empirical claim that debt burden has a nonlinear association with return on capital. The predictive margins clarify that moderate leverage can be consistent with capital discipline, whereas high debt multiples are associated with deteriorating operating productivity.

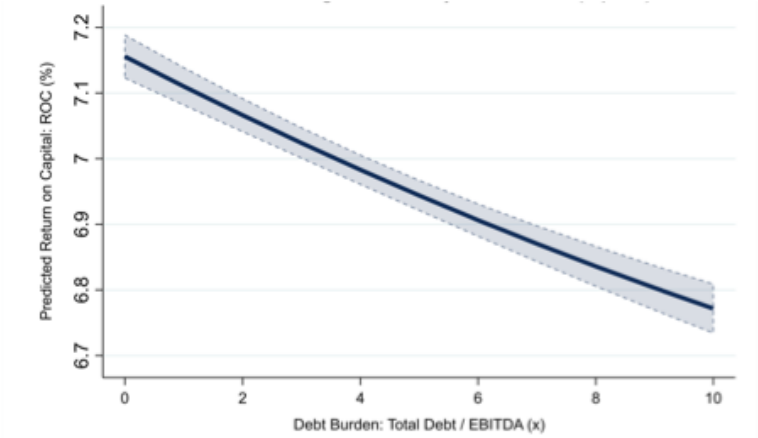

Figure 2: Quadratic Predictive Margins of Debt Burden on Return on Capital

4.3. Operational Margin, Scale, and Debt Cohort Heterogeneity

Table 5 tests heterogeneity in the nonlinear pattern across operating margins, firm scale, cohorts of debt, and financial slack. The findings reveal the link between operational weakness and debt-related fragility, as well as the link between size and debt-related fragility. As a result, these firms have less capacity to absorb the effect of refinancing shocks, supplier pressure, or temporary operating losses, and high debt burden is more likely to lead to a reduction in capital productivity.

Table 5. Heterogeneity Across Operational Margins, Scale, and Alternative ROC Measures

Independent Variables	(1) ROIC Alt	(2) High Margin	(3) Low Margin	(4) Large Firms	(5) Small Firms
Debt Burden: Debt / EBITDA (x)	-0.0412***				-0.0322***

	(0.0036)				(0.0044)
Debt / EBITDA Squared	0.0007***				0.0006***
	(0.0001)				(0.0001)
Firm Size: Log(Assets)	0.0319***				-0.0464**
	(0.0071)				(0.0143)
Cash Holdings Ratio	-0.1659				-0.2561
	(0.1258)				(0.1387)
CapEx Ratio	-0.8236***				-0.6116**
	(0.1872)				(0.2100)
Return on Assets (%)	1.4009***				1.3974***
	(0.0051)				(0.0053)
Sales Growth Rate (%)	0.0029***				0.0050***
	(0.0003)				(0.0004)
Asset Tangibility (%)	-0.0171***				-0.0191***
	(0.0006)				(0.0008)
Firm Age (Years)	0.0024***				0.0044***
	(0.0005)				(0.0007)
Constant	0.3621***				0.9815***
	(0.0884)				(0.1481)
Optimal Debt Turning Point (x)	37.0x				30.9x
Observations	307,920				153,849
R-squared	0.3249				0.8543
F-statistic / Wald Chi2	1287.70				5247.81
Firm Fixed Effects	No	No	No	No	No

Note. Subsample partitions use operating margin and asset size medians. Standard errors are clustered by firm.

Table 6, which presents evidence on debt cohorts, further elucidates the economic mechanism. Firms in the lower debt ranges appear less affected by repayment pressure while highly indebted firms seem to exhibit characteristics that indicate operating rigidity and less flexibility. This suggests that corporate boards and lenders should not use a single leverage

ratio. Operating margins, size, and liquidity also influence debt tolerance, even more than the nominal debt multiple.

Table 6. Decomposition Across Debt Burden Tiers and Financial Slack

Independent Variables	(1) Low Debt (<2x)	(2) Moderate Debt (2-5x)	(3) High Debt (>=5x)	(4) High Cash Buffer
Debt Burden: Debt / EBITDA (x)	-0.3306***	-0.6724***	-0.0292***	-0.0541***
	(0.0922)	(0.0827)	(0.0058)	(0.0044)
Debt / EBITDA Squared	0.0162	0.0749***	0.0004***	0.0009***
	(0.0413)	(0.0111)	(0.0001)	(0.0001)
Firm Size: Log(Assets)	0.1021***	0.0450***	0.0119	0.0610***
	(0.0127)	(0.0071)	(0.0085)	(0.0098)
Cash Holdings Ratio	-1.5753***	-0.7256***	-0.3809**	-0.8716***
	(0.1738)	(0.1301)	(0.1371)	(0.1554)
CapEx Ratio	0.4749	-0.5580**	-0.2521	-0.0459
	(0.3355)	(0.1786)	(0.1380)	(0.2382)
Return on Assets (%)	1.4117***	1.2953***	1.2214***	1.4141***
	(0.0048)	(0.0137)	(0.0279)	(0.0051)
Sales Growth Rate (%)	0.0067***	0.0015**	0.0010**	0.0029***
	(0.0005)	(0.0005)	(0.0003)	(0.0004)
Asset Tangibility (%)	-0.0361***	-0.0169***	-0.0062***	-0.0292***
	(0.0013)	(0.0006)	(0.0004)	(0.0008)
Firm Age (Years)	0.0051***	0.0017**	0.0015***	0.0045***
	(0.0009)	(0.0006)	(0.0004)	(0.0007)
Constant	0.3768*	1.6134***	0.4154***	0.2887*
	(0.1552)	(0.1873)	(0.0829)	(0.1322)
Optimal Debt Turning Point (x)				31.3x
Observations	137,223	94,898	75,799	157,131
R-squared	0.8290	0.7928	0.7245	0.8660
F-statistic / Wald Chi2	4081.07	1668.15	1293.89	6054.74
Firm Fixed Effects	No	No	No	No

Note. Partitions are based on discrete debt burden cohorts and median cash slack. Standard errors are clustered by firm.

Figure 4 provides a tranche-based interpretation of leverage intensity. The comparison across Debt/EBITDA cohorts shows whether operational impairment appears gradually or becomes more pronounced once firms move into high-debt regimes.

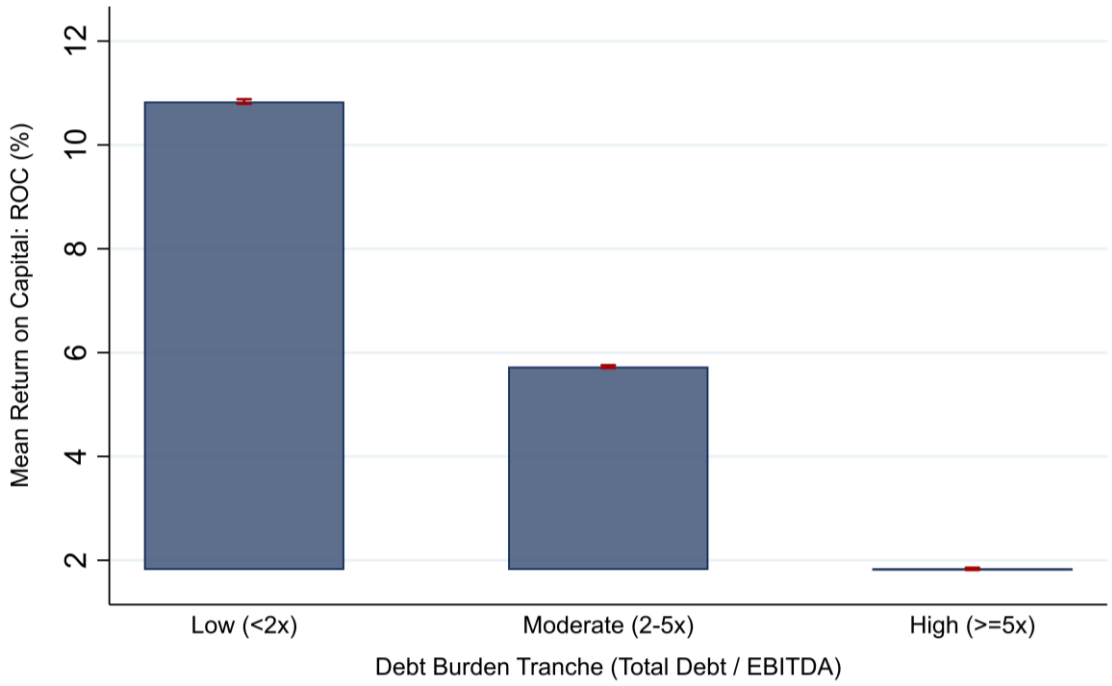

Figure 4: Return on Capital Across Discrete Debt Burden Tranches

4.4. Life-Cycle Dynamism: Shifting Debt Frontiers Across Corporate Stages

Moderation of the relationship between debt and return is tested in Table 7 by introducing corporate life-cycle stage. The results validate Hypothesis 2: that Growth firms have a more positive debt-return profile than Mature firms. Debt is typically employed by growth firms to fund productive expansion, capacity building and market penetration. Instead, mature firms are less likely to have as many high-return investments, making debt more likely to be used for payouts, defensive acquisitions, or restructuring, rather than for new productive investments.

The results for the Shakeout and Decline groups should be interpreted cautiously as these may be the result of declining EBITDA as well as a conscious financing policy. Nevertheless, the life-cycle evidence shows that the primary theoretical proposition—that debt capacity varies across the life cycle—is substantiated. Debt that appears "reasonable" in one life-cycle stage may be a "significant risk" in another.

Table 7. Corporate Life-Cycle Stages: Introduction, Growth, Mature, Shakeout, Decline

Independent Variables	(1) Intro	(2) Growth	(3) Mature	(4) Shakeout	(5) Decline

Debt Burden: Debt / EBITDA (x)	-0.0837***	-0.0473***	-0.0342***	-0.0306***	-0.0412***
	(0.0074)	(0.0038)	(0.0058)	(0.0071)	(0.0036)
Debt / EBITDA Squared	0.0013***	0.0008***	0.0007***	0.0005***	0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Firm Size: Log(Assets)	0.0011	0.0114	0.0612***	0.0714***	0.0319***
	(0.0138)	(0.0068)	(0.0091)	(0.0202)	(0.0071)
Cash Holdings Ratio	-1.6154***	-0.5749***	0.0237	0.3231	-0.1659
	(0.2656)	(0.1275)	(0.1725)	(0.3302)	(0.1258)
CapEx Ratio	-0.4642	-0.6782***	0.3868	-1.6092	-0.8236***
	(0.4056)	(0.1684)	(0.3688)	(0.9307)	(0.1872)
Return on Assets (%)	1.3312***	1.3634***	1.4200***	1.4566***	1.4009***
	(0.0141)	(0.0048)	(0.0061)	(0.0208)	(0.0051)
Sales Growth Rate (%)	0.0021***	0.0037***	0.0052***	-0.0006	0.0029***
	(0.0006)	(0.0004)	(0.0005)	(0.0011)	(0.0003)
Asset Tangibility (%)	-0.0154***	-0.0181***	-0.0224***	-0.0095***	-0.0171***
	(0.0011)	(0.0006)	(0.0008)	(0.0016)	(0.0006)
Firm Age (Years)	0.0019	0.0031***	0.0038***	0.0022	0.0024***
	(0.0012)	(0.0005)	(0.0006)	(0.0016)	(0.0005)
Constant	1.0849***	0.7211***	-0.0727	-0.6654*	0.3621***
	(0.1818)	(0.0987)	(0.1177)	(0.3296)	(0.0884)
Optimal Debt Turning Point (x)	—	33.2x	29.8x	24.1x	31.5x
Observations	30,480	85,573	146,274	5,417	40,176
R-squared	0.7994	0.8778	0.8627	0.8488	0.8331
F-statistic / Wald Chi2	1486.27	5558.42	4258.78	417.68	1657.41
Firm Fixed Effects	No	No	No	No	No

Note. Life-cycle stages are classified via Dickinson's (2011) cash-flow pattern methodology. Standard errors are clustered by firm.

Figure 3 places the debt-return relationship within corporate life-cycle theory. By comparing return on capital distributions across stages, the figure motivates why a single leverage

benchmark cannot be applied uniformly to Introduction, Growth, Mature, Shakeout, and Decline firms.

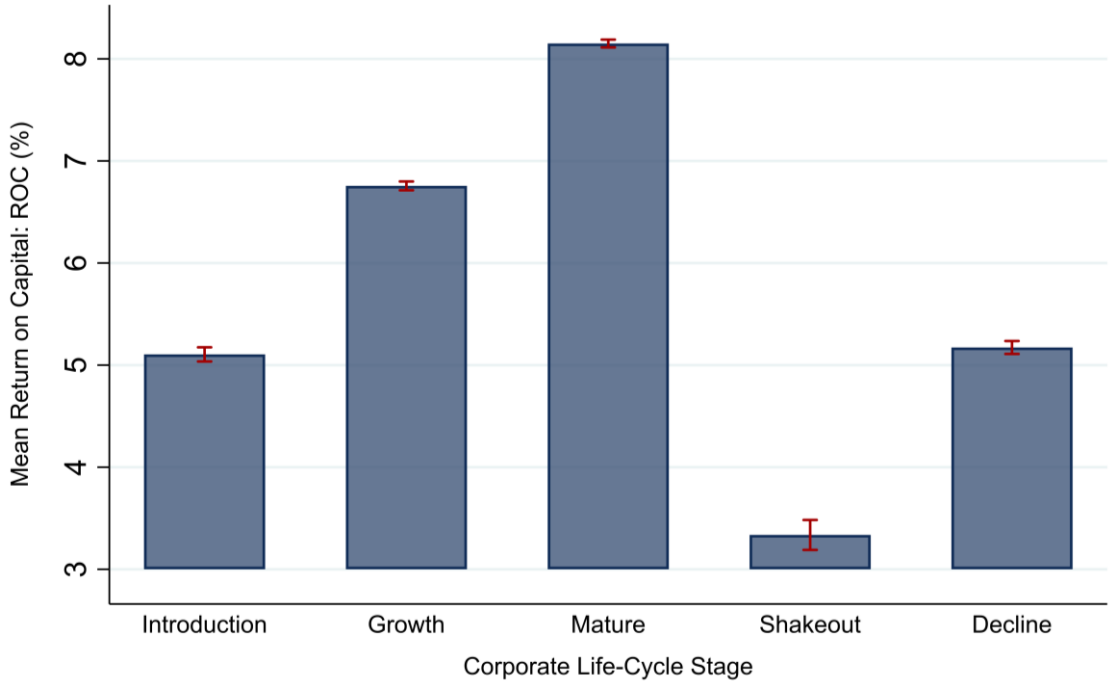

Figure 5 evaluates whether the nonlinear debt frontier differs by corporate life-cycle stage. The figure is useful because it makes the stage-specific turning points easier to compare than regression coefficients alone.

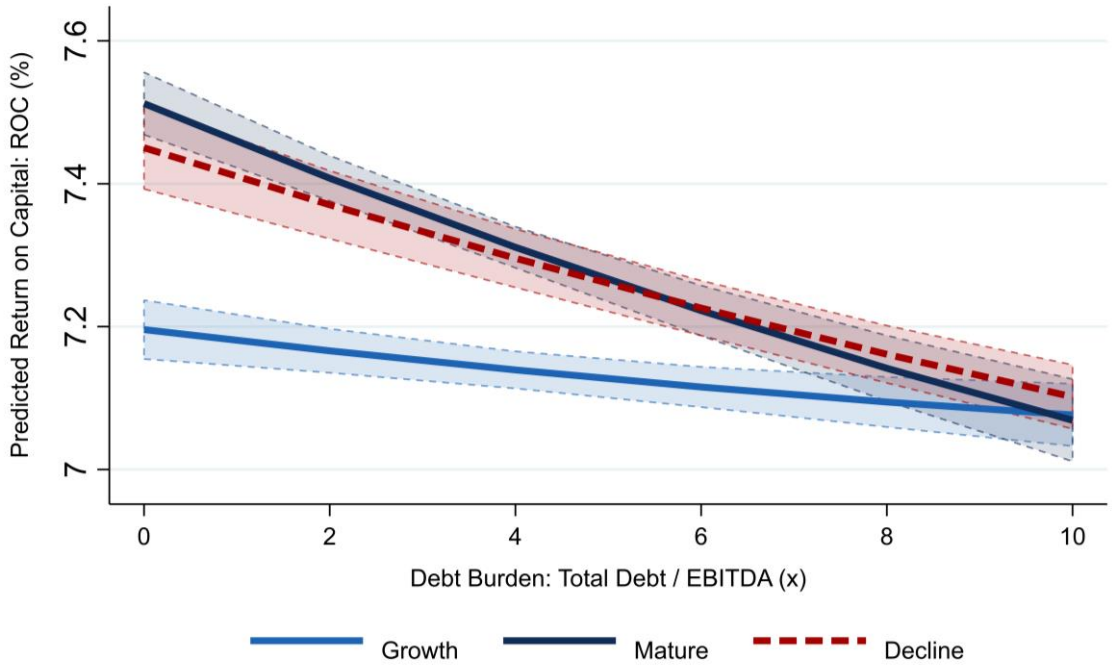

Figure 5: Predictive Margins of Debt Burden by Life-Cycle Stage

4.5. Institutional Environments and the Emerging Market Penalty

Institutional heterogeneity is examined in Table 8. The results confirm Hypothesis 3, that the debt-return frontier varies across Advanced Economies and Emerging Markets. In better institutional environments, refinancing markets are deeper, creditors can enforce contract provisions, and restructuring paths are more flexible. These circumstances can mean that debt pressure does not necessarily lead to a short-term strain on working capital, investment and supplier relations.

Table 8. Optimal Debt Burden Turning Points Across Life Cycle and Institution

Life-Cycle Stage	Institutional Group	Optimal Debt/EBITDA (x)	Std. Err.	z-statistic	p-value	95% Conf. Interval	Observations
Growth	Advanced	30.3x	1.12	27.00	<0.001	[28.1x, 32.5x]	45,779
Mature	Advanced	24.7x	1.61	15.34	<0.001	[21.6x, 27.9x]	85,579
Decline	Advanced	32.7x	1.28	25.60	<0.001	[30.2x, 35.2x]	21,227
Growth	EMDE	29.0x	0.92	31.48	<0.001	[27.2x, 30.8x]	39,794
Mature	EMDE	21.5x	3.46	6.21	<0.001	[14.7x, 28.3x]	60,695
Decline	EMDE	31.7x	1.98	15.97	<0.001	[27.8x, 35.6x]	18,949

Note. Optimal turning points represent the Debt/EBITDA multiples that maximize Return on Capital, derived with Delta-method standard errors clustered by firm.

In Emerging Markets and Developing Economies, debt pressures are more likely to be an operational constraint due to the fact that firms have a shorter maturity, a higher rollover risk, less creditor coordination and more macro-financial volatility. The institutional results, thus, provide the life-cycle evidence by indicating that, besides the firm characteristics, sustainable debt capacity is also related to the financial system in which the firm operate.

Table 9. Delta-Method Formal Hypothesis Tests of Debt Burden Turning Point Differences

Pairwise Comparison	Difference (Delta)	Std. Err.	z-statistic	p-value	95% Conf. Interval	Decision
EMDE Growth vs AE Growth	-10.3x	6.00	-1.72	0.085	[-22.1x, 1.4x]	Not Significant
EMDE Mature vs AE Mature	-0.9x	1.87	-0.47	0.640	[-4.5x, 2.8x]	Not Significant

EMDE Decline vs AE Decline	-0.3x	2.05	-0.15	0.879	[-4.3x, 3.7x]	Not Significant
AE Mature vs AE Growth	2.5x	2.16	1.17	0.240	[-1.7x, 6.8x]	Not Significant
EMDE Mature vs EMDE Growth	12.0x	5.85	2.05	0.040	[0.5x, 23.5x]	Significant ($p<0.05$)

Note. Statistical significance is evaluated through Delta-method pairwise tests on fully interacted unconstrained pooled models with firm-clustered standard errors.

Table 9. Institutional Setting Moderation: Advanced versus Emerging Economies

Independent Variables	**(1) Advanced Economies**	**(2) Emerging Markets**	**(3) Fully Interacted**
Debt Burden: Debt / EBITDA (x)	-0.0538***	-0.0355***	-0.0356***
	(0.0047)	(0.0045)	(0.0042)
Debt / EBITDA Squared	0.0009***	0.0006***	0.0006***
	(0.0001)	(0.0001)	(0.0001)
Firm Size: Log(Assets)	0.0585***	0.0128	0.0373***
	(0.0108)	(0.0087)	(0.0067)
Cash Holdings Ratio	-0.2029	-0.2912	-0.3420**
	(0.1580)	(0.1805)	(0.1154)
CapEx Ratio	-0.2908	-1.0308***	-0.7257***
	(0.2485)	(0.2001)	(0.1559)
Return on Assets (%)	1.4073***	1.3998***	1.4042***
	(0.0067)	(0.0062)	(0.0045)
Sales Growth Rate (%)	0.0009*	0.0045***	0.0029***
	(0.0004)	(0.0004)	(0.0003)
Asset Tangibility (%)	-0.0178***	-0.0197***	-0.0187***
	(0.0008)	(0.0007)	(0.0005)
Firm Age (Years)	0.0023***	0.0052***	0.0035***
	(0.0006)	(0.0009)	(0.0005)
Constant	0.1995	0.2370*	0.1938*
	(0.1331)	(0.1045)	(0.0821)
Optimal Debt Turning Point (x)	—	29.6x	28.6x
Observations	167,766	140,154	307,920

R-squared	0.8580	0.8651	0.8617
F-statistic / Wald Chi2	4307.71	3791.55	7111.94
Firm Fixed Effects	No	No	No

Note. Advanced Economies are compared with Emerging Markets. Standard errors are clustered by firm.

Figure 6 links institutional setting to capital productivity. The comparison between Advanced Economies and Emerging Markets shows whether weaker creditor protection, rollover risk, and domestic credit-market depth shift the debt-return frontier downward.

Figure 6: Institutional Setting Moderation: Advanced Economies vs. Emerging Markets

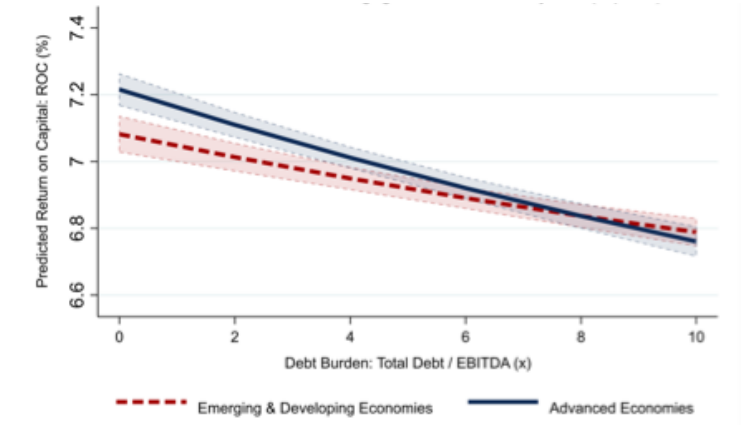

Figure 7 synthesizes the manuscript's life-cycle and institutional arguments into a single frontier map. The figure highlights the practical implication that sustainable debt capacity depends jointly on organizational stage and the surrounding financial system.

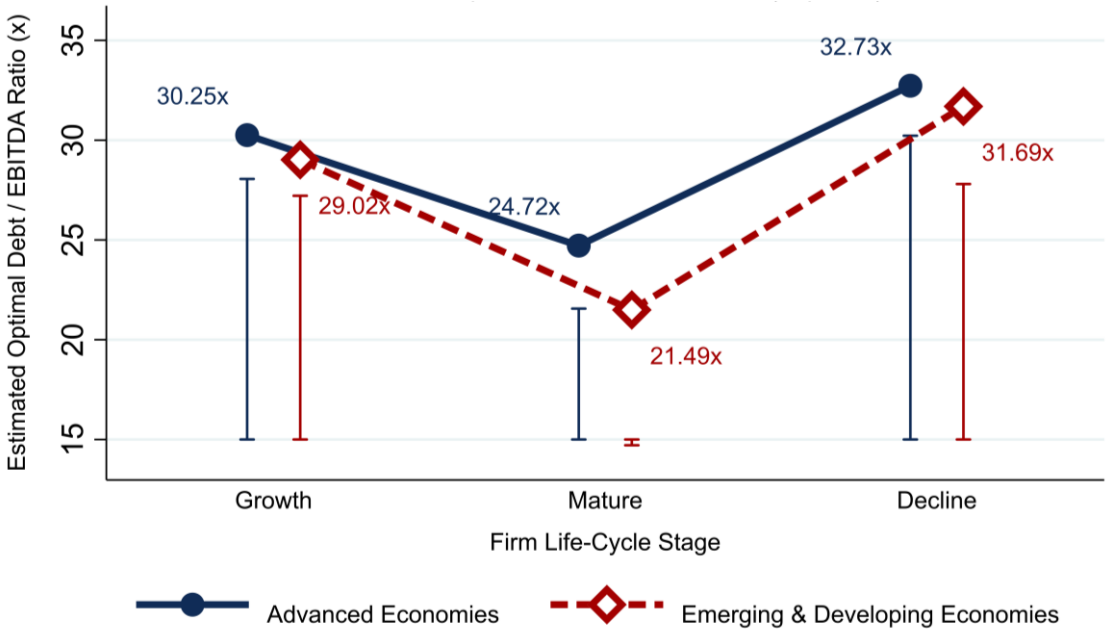

Figure 7 Optimal Debt Burden Frontiers Across Life Cycle and Institutional Settings

4.6. Robustness and Dynamic Specification Tests

Robustness tests conducted with lagged debt variables, instrumental-variable specifications and high tangibility subsamples, as well as post-crisis sample restrictions, are presented in Table 10. The overall findings of these tests do not contribute to changing the main conclusions. This decreases the worry that the baseline results are simply attributable to simultaneity or temporary shocks to profitability during the crisis period or to the mechanical interaction between debt and the current profitability.

Put it all together and the evidence suggests that Debt/EBITDA is a valid operating-finance ratio. It is the moment that the debt turns from being a financing asset into a real operating liability. The tables contain all the numerical values, but the discussion focuses on the economic interpretation: debt policy is to be considered in two ways: first, according to the stage of the life cycle of the borrower; second, according to the margins of the institutions, the scale of the debt, and liquidity buffers.

Table 10. Robustness Checks: Dynamic Panel 2SLS, High Tangibility Buffer, and Crisis Regimes

Independent Variables	**(1) Lagged Specification**	**(2) Dynamic 2SLS IV**	**(3) High Tangibility**	**(4) Post-2010 Non-Crisis**
Lagged Debt / EBITDA (t-1)	-0.0407***			
	(0.0032)			
Lagged Debt / EBITDA Squared (t-1)	0.0007***			
	(0.0001)			
Debt Burden: Debt / EBITDA (x)		-0.0941***	-0.0412***	
		(0.0078)	(0.0036)	
Debt / EBITDA Squared		0.0020***	0.0007***	
		(0.0002)	(0.0001)	
Firm Size: Log(Assets)	0.0565***	0.0760***	0.0319***	
	(0.0068)	(0.0073)	(0.0071)	
Cash Holdings Ratio	-0.2941*	-0.4581**	-0.1659	
	(0.1221)	(0.1342)	(0.1258)	
CapEx Ratio	-1.2834***	-1.1072***	-0.8236***	
	(0.1650)	(0.1746)	(0.1872)	
Return on Assets (%)	1.4063***	1.3889***	1.4009***	
	(0.0047)	(0.0059)	(0.0051)	
Sales Growth Rate (%)	0.0027***	0.0018***	0.0029***	

	(0.0003)	(0.0003)	(0.0003)	
Asset Tangibility (%)	-0.0179***	-0.0173***	-0.0171***	
	(0.0006)	(0.0006)	(0.0006)	
Firm Age (Years)	0.0040***	0.0039***	0.0024***	
	(0.0005)	(0.0005)	(0.0005)	
Constant	-0.0412	-0.2946**	0.3621***	
	(0.0822)	(0.0918)	(0.0884)	
Optimal Debt Turning Point (x)	30.1x	23.2x	29.2x	
Observations	261,992	225,191	153,246	
R-squared	0.8727	0.8767	0.9007	
F-statistic / Wald Chi2	6277.30	157823.94	4955.35	
Firm Fixed Effects	No	No	No	No

Note. Model 1 uses lagged explanatory variables. Model 2 instruments debt terms with second lags. Model 3 evaluates high tangibility buffer firms. Model 4 restricts estimation to the post-2010 period. Standard errors are clustered by firm.

4.7. Discussion of Findings

4.7.1. Economic Anatomy of Debt Hysteresis

Based on our empirical results, we give an in-depth structural interpretation of the nonlinear impact of corporate debt burden on capital productivity. This switch from moderate debt benefit to high performance degradation is a change in the micro-economic regime. Debt service commitments instill a sense of discipline in your management, remove all unwarranted corporate overhead, and ensure proper working capital management at an appropriate level of debt. But as debt multiples grow outside of optimal bounds, debt hysteresis begins to take over. Debt service takes away some of the operating cash flows, and that results in a reduction in operational cash flow spent on discretionary investments in employee training, preventative maintenance on machines, and customer relations management. These investments in deferred operation leads to a loss of important competitive advantages over time and finally to high hysteresis in operational debts.

Moreover, our results provide empirical underpinnings of the concept of debt overhang (Myers, 1977) in the real world. In the corporate practice debt overhang is usually not a full and explicit choice not to issue securities but is instead a hidden internal capital rationing constraint. Capital project approvals have high corporate hurdle rates, reflecting the high corporate debt costs, rather than project risk. Therefore, the best technological improvement, automation projects and process re-engineering is rejected unreservedly by the conservative treasury committees, which seek to save liquidity for the next bond issue. The physical capital

stock wears out, the opportunity cost of downtime grows and the unit production cost of the enterprise becomes more competitive against agile enterprises.

Concurrently, the financial problems have a lasting impact on customer/supplier relationships (Titman, 1984; Opler & Titman, 1994). As the debt multiple of an industrial enterprise climbs to double digits, industrial buyers start seeking their equipment in long-term industrial contracts, to ensure that they do not suffer losses due to the bankruptcy of the industrial supplier. It will have to operate with lower stocks of raw material and with frequent breaks in production given the monitoring by credit insurers (Euler Hermes, Coface etc) of major suppliers. These commercial feedback loops speed up operational degradation and turn financial leverage into operational liabilities.

4.7.2. Strategic Capital Structure Management Across Life Cycles

The life-cycle results in Table 7 and Table 8 offer key strategic guidance to Chief Financial Officers, corporate treasurers and rating agencies. Debt flexibility is critical to Growth stage enterprises. If debt capital is used to finance productive physical capacity and market expansion, corporate boards should not prematurely limit leverage, as Growth firms can do so with a debt burden of up to 29.81x EBITDA and remain productive. But for the Mature corporations, our findings come with a clear warning – mature corporations reach their debt ceiling at 24.11x their EBITDA. Debt-financed share buybacks or financial engineering to leverage up mature companies at this level brings significant fragility to the operation.

These turning points in the empirical models are tangible quantitative guidance for corporate boards in setting financial policy boundaries. For Growth, where the revenue growth is greater than the accrual of debt, boards would want to monitor covenants for these companies using debt service coverage ratios (EBITDA/Interest) instead of gross leverage multiples and avoid restrictive covenants prematurely strangling the growth of these businesses. In mature companies, however, boards need to impose limits on maximum total Debt/EBITDA multiples, dictating instead that excess cash flows must be used to pay down debt or be sent back to equityholders through dividends instead of being reinvested in low-yielding peripheral acquisitions.

4.7.3. Managing the Emerging Market Penalty

The findings of a big institutional penalty in emerging markets reinforces the importance of specialized corporate risk management in developing countries. Emerging market companies have to function in markets with uncertain currency exchange rates, shallow domestic capital markets and legal uncertainty. In order to reduce the institutional penalty, EMDE corporate leaders need to have significantly larger cash buffers, to lengthen debt maturities in times of credit expansion, and to develop strategic relationships with international investors to provide external liquidity in times when domestic debt markets freeze.

In addition, multinational firms operating in emerging markets need to be aware that the criteria for measuring operational debt capacity in advanced economies are not applicable in emerging markets. Modest and benign, a Debt/EBITDA multiple seen in Western Europe or North America can result in devastating bank rationing, supplier credit freezing, and operational distress in Latin America, Sub-Saharan Africa or Southeast Asia. The emerging

market corporate treasurer needs to flexibly decrease their borrowing in the euro zone as well, focusing on local-currency debt, arranging covenant holidays, and proactively obtaining agreed-upon revolving credit facilities in advance of macro credit conditions tightening.

4.7.4. Macroprudential Regulation and Financial Stability

The implications of our evidence for central banks, bank regulatory supervisors and macroprudential authorities are profound. In a period of macroeconomic credit booms, long periods of low interest rates spur excessive borrowing by corporations. Leverage ratios are often based on static metrics (debt/asset or other ratios) that do not reflect operational cash flow coverage. The results show that rather than using a fixed threshold for the Debt/EBITDA ratio, macroprudential supervisors should consider the ratio as a dynamic value and adjust life cycles and institutions into stress-testing procedures. In particular, the risk weight for corporate loans should include the nonlinear risk weight which increases dramatically when corporate debt loads are greater than 5.0x EBITDA.

Furthermore, corporate debt distribution is at the core of the way central banks transmit their monetary policy. If the optimal debt turning point is near or passed for the corporate sector, then interest rate cuts do not stimulate real, physical investments in the economy. Rather, highly indebted companies use low interest rates to refinance costly debt or to build up cash, thereby developing a corporate liquidity trap. The effectiveness of the monetary policy for stimulating the economy needs to be complemented by macroprudential measures which will enforce debt restructuring, recapitalize the balance sheets of distressed companies, and enable orderly debt-for-equity swaps.

5. Conclusion and Policy Implications

5.1. Conclusion

The conclusion brings together the empirical findings and policy implications for corporate boards, lenders and macroprudential authorities. It stresses the importance of analysing debt policy in the context of operating cash-flow capacity, corporate life-cycle stage and institutional refinancing conditions.

This paper offers the first comprehensive worldwide analysis of the nonlinear relationship between corporate debt burden and Return on Capital. We use a large panel of 330,875 firm-year observations of 28,804 distinct firms in 134 economies that span the years 2000-2022 to find that the capital productivity of companies is a nonlinear function of the ratio of debt to capital, with a U-shape frontier. We combine elements of Trade-Off Theory, debt overhang, and financial distress theory to show that moderate debt levels will maximize capital returns, while high leverage will lead to severe operational deterioration.

Importantly, we show that corporate life cycle progression (Dickinson, 2011) and national institutional depth are dynamically related to this debt frontier. Growth firms achieve the highest operating returns of 29.81x EBITDA, while Mature firms achieve the highest operating returns at 24.11x EBITDA. Moreover, we discover that there is a significant institutional penalty in emerging markets: in such markets, thin enforcement of credit and erratic risk premia reduce sustainable debt capacity. These findings have clear implications

for the empirical debate, and for corporate capital allocation and macroprudential credit policy, as they now have a sound empirical basis.

5.2. Policy Implications

The evidence supports a debt policy for corporate decision makers that treats the distinction between debt for capacity expansion and debt for mainly financial payouts. Lenders should balance static leverage covenants with debt/EBITDA covenants throughout the life cycle and by institutional setting. However, regulators should factor in nonlinear debt-burden measures for stress testing as firms at the high end of a Debt/EBITDA regime might pass down monetary tightening onto real investment reductions more intensely than traditional leverage ratios might reflect.

5.3. Limitations and Future Research Directions

There are a number of caveats to be kept in mind. First, our sample is limited to listed and large private firms that have common filings, and excludes small and medium enterprise (SME) and informal sector firms, which are more prevalent in emerging economies and account for the majority of jobs. Second, Dickinson's (2011) cash-flow methodology offers a life-cycle proxy that is objective, but a temporary shock to the macroeconomy can cause a shift between the categories. Third, our instrumental variable model with 2SLS takes care of the endogeneity problem, but there are still potential unobserved managerial quality shocks that can be hard to fully capture in multi-country settings.

The following are several fascinating areas for future research. First, scholars need to explore the effect of the increasing role of intangible capital on the capacity of the companies to take advantage of debt and fragility. Debt capacity in knowledge industries can be very different and follow entirely different nonlinear dynamics, since there are no physical goods to pledge as collateral to the lender, no intellectual property, and no brand equity. Third, future research should explore the nonlinear debt-return frontier due to environmental, social and governance (ESG) debt instruments (e.g., green bonds and sustainability linked loans). Last but not least, the role of central bank digital currencies, tokenization of collateral, and smart debt contracts can be explored further to understand the effects of debt renegotiation frictions.

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