

Institutional embeddedness and financial strategy in global value chains: evidence from the semiconductor industry in East Asia

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Abstract

Purpose – This study aims to investigate how firms' positions within global semiconductor value chains shape their capital-structure decisions under varying institutional environments. It aims to clarify whether leverage is primarily determined by supply chain role, integration scope or institutional quality.

Design/methodology/approach – Using an unbalanced panel of 496 listed semiconductor firms across 26 countries from 2004 to 2022, we combine fixed-effects, correlated random effects and dynamic panel estimations. The analysis incorporates firm-level financial data and sector classifications. A two-step system generalized method of moments estimator is employed to mitigate endogeneity arising from leverage persistence, reverse causality and omitted variables. Robustness checks include alternative leverage definitions, winsorized samples and variance inflation factor diagnostics.

Findings – Functional specialization, rather than regional context or integration level, emerges as the primary determinant of leverage. Upstream firms exhibit significantly higher debt ratios than midstream counterparts, consistent with trade-off theory and capital-intensity arguments. The dynamic model confirms that leverage is persistent over time, while East Asian firms display lower leverage – suggesting that institutional support increasingly operates through equity participation and public investment rather than debt financing.

Research limitations/implications – Future research should explore instrumental-variable or matching designs and extend institutional measures to include policy-level and subregional indicators.

Originality/value – The study bridges corporate finance and global value chain research by integrating institutional quality into a dynamic, role-based model of capital structure. It demonstrates that supply chain position and institutional conditions jointly explain financial heterogeneity in high-technology industries.

Keywords Capital structure, Semiconductor industry, Global value chains, Institutional embeddedness, International financial strategy

Paper type Research article

1. Introduction

The capital structure decisions of firms are a foundational topic in finance, particularly regarding how companies balance debt and equity to finance operations and growth. While traditional theories such as the trade-off theory (Myers, 1984) and pecking order theory (Myers and Majluf, 1984) emphasize firm-specific factors like profitability, asset tangibility, and size, growing attention has turned to the roles of institutional context, industry structure, and supply chain positioning in shaping financial strategies (Frank and Goyal, 2009; Fan *et al.*, 2012).

This paper investigates capital structure determinants in the context of the global semiconductor industry, where firms operate in vertically disaggregated value chains and face varying capital intensity and risk profiles. In particular, we examine how three key structural characteristics affect leverage outcomes: (1) the firm's functional position in the supply chain,



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(2) its institutional embeddedness, especially within East Asian markets, and (3) its level of operational integration across multiple supply chain segments.

The semiconductor industry presents an ideal setting for this analysis. It comprises highly specialized segments such as upstream equipment manufacturing and wafer fabrication (SW), midstream design and logic processing, and downstream packaging and assembly. Each segment differs in fixed capital requirements, payback horizons, and financing needs. Moreover, institutional environments in East Asia – characterized by coordinated industrial policy, state-led financing, and public-private R&D initiatives – introduce additional variation in financial support and leverage behaviour.

Organizational structure is also relevant. Some firms focus narrowly on a single supply chain function, while others operate across multiple stages to capture synergies or internal capital market benefits. Such integration may affect access to internal financing, risk sharing, and reliance on external debt.

Using a proprietary panel dataset of 496 firms from 2004 to 2022, we construct measures of supply chain role, geographic-institutional context, and segmental integration. We employ pooled and random effects (RE) regressions to estimate the impact of these characteristics on net debt-to-equity ratios, controlling for firm size, profitability, and macroeconomic conditions.

Our findings show that firms engaged in upstream capital-intensive functions maintain significantly higher leverage compared to their midstream counterparts. However, we do not find consistent evidence that institutional advantages in East Asia or multi-segment integration are associated with significant differences in leverage. These results suggest that capital structure in fragmented global industries is primarily driven by functional production roles rather than geographic origin or organizational scope.

This study contributes to the literature on international corporate finance by integrating production network positioning and institutional context into capital structure analysis. It offers implications for financial managers and policymakers in capital-intensive industries and contributes to understanding how supply chain roles shape financial decisions in international markets.

2. Literature review

2.1 *Capital structure and international financial contexts*

Research on capital structure traditionally centres on firm-level characteristics, emphasizing how profitability, growth, asset tangibility, and firm size affect the trade-off between debt and equity (Myers, 1984; Rajan and Zingales, 1995). The pecking order and trade-off theories have informed much of this thinking, predicting that firms with greater internal resources prefer retained earnings, while firms facing higher fixed costs may benefit from debt tax shields (Myers and Majluf, 1984).

However, emerging literature highlights that these determinants are insufficient in international contexts where firms face institutional and structural heterogeneity. La Porta *et al.* (1998) and De Jong *et al.* (2008) demonstrate how institutional quality, legal origin, and investor protection influence financial policy across countries. Fan *et al.* (2012) extend this view to multinational enterprises, showing how national context and governance shape firm leverage. This stream of research supports the inclusion of institutional and regional variables in capital structure models, especially for firms embedded in complex cross-border industries.

2.2 *Functional specialization and capital intensity in global supply chains*

Beyond country-level institutions, firms' functional roles in global value chains also affect their financing needs. Industries such as semiconductors, characterized by vertical disintegration and high technological specialization, exhibit sharp variation in capital intensity and financial risk by production stage (Gereffi *et al.*, 2005; Coe and Yeung, 2015).

Upstream functions (e.g. semiconductor equipment, SW) involve large fixed investments, extended development cycles, and substantial sunk costs. These characteristics are expected to correlate with greater leverage.

By contrast, midstream and downstream segments (e.g. chip design, packaging and testing) generally feature shorter innovation cycles, higher asset turnover, and reduced capital intensity. Empirical research suggests that such structural differentiation influences firms' reliance on debt, liquidity management, and investment behaviour (Frank and Goyal, 2009; Chung and Luo, 2008). Yet the finance literature has only begun to incorporate functional supply chain roles into leverage models.

2.3 Institutional embeddedness and East Asian industrial financing

Firms do not operate in isolation but are embedded in national institutional frameworks that shape access to credit, regulatory constraints, and financial incentives (Hall and Soskice, 2001). In particular, East Asian economies – such as Taiwan, South Korea, Japan, and China – have actively cultivated semiconductor industries via targeted industrial policies. These include public-private R&D funding, state-owned banking support, and export credit schemes (Mathews, 2006; Wong, 2011).

The concept of “strategic coupling” in global production network (GPN) theory captures how firms in East Asia integrate with regional institutions to gain competitive advantage in capital-intensive sectors (Yeung, 2009, 2022). While this process has been analyzed in terms of technological upgrading and production coordination, its implications for financial policy – specifically leverage decisions – remain underexplored in the corporate finance literature.

2.4 Organizational scope and internal capital markets

Organizational structure is another factor shaping capital structure decisions. Firms operating across multiple supply chain stages may benefit from internal capital markets, which can reallocate resources more efficiently and reduce dependence on external finance (Stein, 1997; Khanna and Yafeh, 2007). From a resource-based perspective, diversification enhances financial flexibility, buffers against market volatility, and creates opportunities for risk sharing.

However, empirical findings are mixed. While some studies find that integration improves liquidity and reduces borrowing, others caution against internal inefficiencies and agency costs. The extent to which supply chain integration moderates leverage is especially relevant in the semiconductor industry, where firms increasingly pursue upstream-downstream synergies to manage technological complexity and competitive pressures.

2.5 Recent developments in global value chains and capital structure research

Recent evidence underscores that semiconductor global value chains have been reconfigured through policy and geopolitical shocks, with functional upgrading, geographic re-anchoring, and capacity realignments particularly visible post-2018 (trade measures) and post-2020 (COVID). These shifts alter financing needs and risk exposures across upstream, midstream, and downstream segments (Yeung et al., 2023).

To capture persistence in leverage and dynamic adjustment consistent with modern capital-structure practice, we augment our static panel with a dynamic specification estimated via system generalized method of moments (GMM), following Blundell and Bond (1998) with Windmeijer (2005) finite-sample corrections and instrument-design guidance per Roodman (2009). Our approach complements recent firm-level work linking GVC engagement to performance outcomes (e.g. Elshaarawy and Ezzat, 2023) and supply-chain financing constraints under heightened risk (Lam and Zhan, 2021), thereby situating capital-structure choices within evolving production networks rather than purely within-firm equilibria.

3. Hypotheses development

This section develops the study's three hypotheses by integrating theoretical perspectives from corporate finance, institutional theory, and GVC analysis. In particular, we draw on prior research that emphasizes how firm-level financing strategies are shaped not only by internal factors, but also by the firm's functional role in production, its national institutional context, and its organizational structure. These multi-level determinants provide a framework for understanding capital structure in industries like semiconductors that are capital-intensive, fragmented, and geopolitically strategic.

3.1 Functional position and capital structure

Traditional theories of capital structure – such as the trade-off theory (Myers, 1984; Kraus and Litzenberger, 1973) and pecking order theory (Myers and Majluf, 1984) – emphasize that firms balance the tax benefits of debt against the costs of financial distress and information asymmetry. However, these theories often overlook the structural differences across industries and production functions.

Recent studies in international corporate finance and industrial organization have underscored how capital intensity and asset specificity vary by position in the supply chain, particularly in high-tech sectors like semiconductors (Frank and Goyal, 2009; Fan *et al.*, 2012). Upstream semiconductor firms – engaged in equipment production, SW, and materials – require substantial fixed investment and have longer payback periods. These features increase their need for external financing, particularly long-term debt, to manage cash flow volatility and technological risk (Rajan and Zingales, 1995; Coe and Yeung, 2015).

By contrast, midstream and downstream firms – such as fabless chip designers or packaging and testing providers – tend to operate with higher asset turnover and lower capital intensity. These firms are more likely to use internal funding or equity to maintain flexibility and avoid the costs associated with over-leverage (Harris and Raviv, 1991; Frank and Goyal, 2003).

Building on this functional logic and GVC theory (Gereffi *et al.*, 2005; Sturgeon and Kawakami, 2011), we posit that a firm's capital structure is partly shaped by its production role in the value chain.

- H1.* Firms in upstream segments of the semiconductor supply chain exhibit higher leverage than those in midstream or downstream segments.

3.2 Institutional context and strategic coupling

Institutional theory posits that national governance frameworks significantly influence firm behaviour, particularly in areas involving legal protections, financial market development, and creditor rights (La Porta *et al.*, 1998; Beck *et al.*, 2008). In East Asia, institutional support for the semiconductor sector has been a hallmark of industrial policy for decades. Governments in countries such as Taiwan, South Korea, China, and Japan have promoted semiconductor development through subsidized credit, public-private research collaborations, sovereign investment vehicles, and state-backed banks (Wong, 2011; Mathews, 2006; Breznitz, 2007).

GPN theory introduces the notion of strategic coupling – the idea that local firms in East Asia can align themselves with both global lead firms and state institutions to gain access to resources and legitimacy (Yeung, 2009, 2022). This coupling facilitates access to capital and lowers financing frictions, particularly for upstream firms engaged in manufacturing or R&D-intensive activities (Hobday, 2003; Ernst, 2005). Strategic integration with the state may also reduce the cost of capital through moral hazard protections, preferential procurement, or informal guarantees (Chang, 2003; Haggard, 2018).

However, the institutional effects on capital structure are not uniform. While East Asian institutions provide debt-friendly environments, they may also foster alternative mechanisms such as equity injections, state equity stakes, or retained earnings buffers (Khanna and Palepu,

2000; Allen *et al.*, 2005). Nonetheless, given the scale and policy prioritization of upstream semiconductor activities, we expect such firms to demonstrate greater leverage in these supportive institutional settings.

- H2. Upstream firms headquartered in East Asia exhibit higher leverage than comparable firms in other regions.

3.3 Organizational integration and financial flexibility

Organizational structure plays a critical role in shaping capital structure decisions. According to the theory of internal capital markets, multi-segment firms can allocate financial resources internally across divisions, thereby mitigating market imperfections and reducing dependency on external capital (Stein, 1997; Khanna and Yafeh, 2007). Resource-based theory also suggests that diversification across functions creates risk-sharing advantages and reduces financial exposure (Barney, 1991; Wernerfelt, 1984).

In the context of semiconductors, vertically integrated firms – those engaged in R&D, design, fabrication, and assembly – may realize both technological and financial synergies (Langlois and Robertson, 1995; Macher and Mowery, 2004). Integration allows firms to coordinate capital investment cycles, buffer against supply-side volatility, and better manage cost structures. This may be particularly relevant for capital allocation under uncertainty and for smoothing cash flows over heterogeneous production activities (Maksimovic and Phillips, 2002).

Yet, integration is not without trade-offs. Empirical studies have shown that diversified firms may suffer from agency problems, bureaucratic inefficiencies, or cross-subsidization of underperforming units (Berger and Ofek, 1995; Rajan *et al.*, 2000). In high-tech sectors, the benefits of functional integration depend on whether firms can align technical complexity with managerial control.

Despite these mixed findings, we hypothesize that integrated semiconductor firms are more likely to fund investment internally and, as a result, exhibit lower external leverage than their specialized counterparts.

- H3. Firms operating across multiple supply chain segments exhibit lower leverage than single-segment firms.

3.4 Conceptual framework

Figure 1 illustrates the conceptual framework that guides this study. It captures the relationships between capital structure (measured by firm leverage) and three explanatory

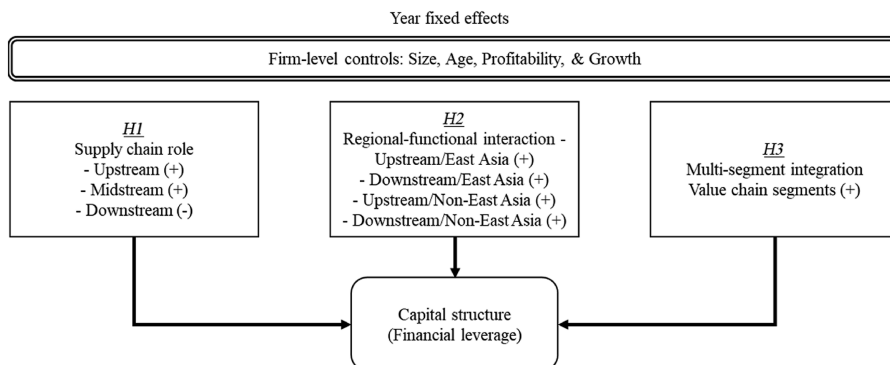


Figure 1. Conceptual framework: determinants of capital structure in global semiconductor firms. Source: Developed by author

dimensions: functional position in the supply chain, institutional context, and organizational integration. These relationships are informed by capital structure theory, institutional economics, and GVC research.

- (1) The first dimension reflects the expected positive association between upstream production roles and leverage due to capital intensity.
- (2) The second dimension highlights the institutional advantage hypothesis, particularly the leverage-enhancing effect of being embedded in East Asian industrial ecosystems.
- (3) The third dimension represents the potential negative association between organizational diversification and leverage, based on internal capital market benefits.

This framework integrates multi-level determinants – firm function, national institutional context, and organizational design – into a single model to examine how semiconductor firms manage financial structure in globally fragmented industries.

4. Data and methodology

To empirically test these hypotheses, we construct a firm-level panel dataset covering semiconductor companies across multiple global regions and supply chain segments. Our research design reflects the theoretical complexity of global production networks by integrating both time-invariant and time-varying firm characteristics. Specifically, we adopt a mixed-method empirical approach that allows us to capture the effects of functional supply chain position (H1), institutional regional context (H2), and organizational integration (H3) on capital structure. We address the methodological challenge of estimating time-invariant variables – central to our theoretical arguments – by complementing fixed effects (FE) estimators with pooled ordinary least squares (OLS) and RE models, thereby balancing causal identification with hypothesis testing. The following section details our data sources, variable construction, and estimation strategy.

4.1 Data source and sample construction

The empirical analysis is based on a proprietary firm-level panel dataset that covers companies active in the global semiconductor supply chain. The dataset spans from 2004 to 2022 and includes 496 unique firms, yielding a total of 10,416 firm-year observations. After applying listwise deletion to handle missing values in key variables such as debt ratios, profitability, and total assets, the effective sample size used for regression analysis is 4,970 firm-year observations. This filtering process ensures the reliability and consistency of the multivariate analysis and conforms to best practices in panel data econometrics.

Each firm is classified into one or more of 23 sector codes based on its functional role in the semiconductor value chain. These codes reflect technological and production-specific positions such as semiconductor production equipment – front-end (SPEF), SW, fabless design (SF), assembly and testing and power semiconductors, among others. Firms that operate across multiple stages in the supply chain are denoted by hyphenated sector codes (e.g. SPEB-SPEF and SD-SP-SL), capturing organizational integration and value chain diversification. To map each firm's functional role within the semiconductor value chain, we adopted a set of sector codes based on industry-recognized classifications. These codes represent specific production segments and reflect technological, operational, and capital intensity distinctions across the value chain. The classification is informed by the Semiconductor Industry Association (SIA) (SIA, 2023) and Yeung *et al.*'s recent study on global semiconductor value chains (Yeung *et al.*, 2023). Table 1 summarizes the sector codes and their corresponding definitions.

To illustrate the geographic and functional coverage of the dataset, [Supplementary Table A1](#) provides a breakdown of firm counts by sector code and country of headquarters.

Table 1. Semiconductor sector codes and value chain segments

Code	Sector
CS	Crystalline Silicon
PM	Photomasks
SPEB	Semiconductor Production Equipment – Back-End
SPEF	Semiconductor Production Equipment – Front-End
SW	Semiconductor Wafers
SAT	Semiconductors – Assembly/Testing
SD	Semiconductors – Discrete
SF	Semiconductors – Fabless
SL	Semiconductors – Logic
SM	Semiconductors – Memory
SP	Semiconductors – Power

Source(s): Developed by author

Countries are identified using three-letter ISO-3 country codes, consistent with the World Bank's classification system (e.g. USA = United States, JPN = Japan, KOR = South Korea, TWN = Taiwan). This tabulation captures the structural diversity of the semiconductor ecosystem and reveals patterns of agglomeration across global production networks. For example, Taiwan (TWN) accounts for the highest number of firms (160), followed by South Korea (KOR, 90), Japan (JPN, 65), and the United States (USA, 54), reflecting their strategic positions in semiconductor manufacturing and technology development.

This country-sector matrix provides a structural overview of functional specialization and regional agglomeration in the semiconductor industry. It illustrates the significant presence of upstream and midstream firms in East Asia (e.g. SPEF in TWN, SW in JPN and KOR), as well as downstream and fabless firms in North America and Europe. Such spatial-functional diversity enables the empirical analysis to examine how capital structure is shaped by a firm's embeddedness in both supply chain position and institutional context.

4.2 Variable operationalization

All variables are drawn from the proprietary firm-level panel dataset used throughout this study. The objective of this section is to describe how existing data were transformed to operationalize the study's theoretical constructs without relying on additional external sources.

Continuous variables were winsorised at the 1st and 99th percentiles to reduce the influence of outliers. [Table 2](#) summarizes descriptive statistics, and complete variable definitions and data sources appear in [Supplementary Table A2](#).

4.3 Dependent variables

4.3.1 Leverage (net D/E). The dependent variable is the net debt-to-equity ratio, calculated as net interest-bearing debt divided by shareholders' equity. This variable captures firms' reliance on external financing and serves as proxies for capital-structure intensity.

4.3.2 Independent variables. **4.3.2.1 Functional role in the supply chain.** Each firm is classified as upstream, midstream, or downstream according to its primary SIA sector code. Upstream firms (e.g. equipment, SW) are the most capital-intensive; midstream firms (e.g. logic, design) depend primarily on intangible assets; downstream firms (e.g. assembly, testing) operate with shorter cycles. The categorical variable *supplychainrole* takes values 1–3 for these positions. Sector assignments were cross-validated by two independent coders with >90% agreement.

4.3.2.2 Institutional and regional context (proxied internally). Rather than introducing new external indicators, institutional heterogeneity is captured using country FE (*i.country*) and

Table 2. Descriptive statistics of main variables and categorical role frequency

Variable	Obs.	Mean	Std. Dev.	Min	Max
Net D/E	7,335	0.16	2.792	0	188
D/E	7,108	0.505	3.759	0	225
Supply_Chain_Role	10,416	2.558	1.089	1	4
Upstream_East_Region	10,416	2.861	0.884	1	4
Segment_Count	10,416	1.058	0.235	1	2
Firm Size	6,242	4.821	1.244	0	7
Firm Age	10,416	24.397	19.771	0	130
ROA	7,792	4.31	13.755	0	224
Operating Profit Margin	8,174	−2.433	258.775	0	107
Sales Growth	7,774	41.37	2184.691	0	192,453
P/B	7,395	3.387	13.195	0	843

Role (categorical)	Frequency	Percent
Upstream	2,849	46.8%
Midstream	2,392	39.3%
Downstream	853	14.0%
Total	6,094	100%

Source(s): Developed by author

East-Asia regional dummies derived from existing headquarters-country data. Interaction terms such as `c.is_eastasia#i.supplychainrole` test whether supply-chain roles behave differently across institutional regimes. This approach internalizes cross-national variation and financial-system differences already embedded in the sample.

4.3.2.3 Organizational integration. Integration across value-chain stages is measured with variables already present in the dataset. `Segmentcount` counts the number of distinct segments in which a firm operates (1 = single-segment; >1 = multi-segment). A binary variable `is_integrated` (= 1 if `segmentcount` >1) and an interaction term `upstream_integ` = `is_integrated` × (upstream) provide robustness. This captures internal capital-market potential and coordination scope without requiring new data.

4.3.3 Control variables. Standard firm-level controls are retained: Firm Size (log of total assets); Firm Age (years since founding); Profitability (ROA) (net income/total assets); Operating Margin (operating income/revenue); Sales Growth (year-over-year change in sales); Market Valuation (P/B) (market-to-book ratio).

All models include year FE (`i.year`) to absorb macroeconomic cycles and policy shifts, and additional dummy variables identify major crises: the 2008–2009 global financial crisis, 2018–2019 U.S.–China trade war, and 2020–2022 COVID-19 period for robustness check.

4.3.4 Data validation. Data consistency was ensured by cross-checking firm identifiers and sector codes. Observations with missing key variables were dropped after inspection; negative or implausible operating margins were removed. After cleaning, the regression sample contains 4,970 firm-year observations across 496 firms. This internal validation guarantees reliability while remaining fully within the existing dataset.

4.4 Empirical estimation strategy

The estimation strategy integrates static and dynamic panel techniques using only the variables contained in the existing dataset. This design allows the study to address potential endogeneity, persistence, and unobserved heterogeneity without importing external indicators.

4.4.1 *Baseline model.* The baseline specification is:

$$\text{Leverage}_{it} = \alpha + \beta_1 \text{FunctionRole}_{it} + \beta_2 \text{Integration}_{it} + \beta_3 (\text{FunctionRole} \times \text{EastAsia})_{it} \\ + \gamma' \text{Controls}_{it} + \lambda_t + \mu_i$$

where Leverage_{it} is the net D/E ratio, λ_t represents year effects, and μ_i captures firm-specific heterogeneity and country and year FE proxy for institutional and macroeconomic variation.

Three complementary estimators are employed; FE control for unobserved firm heterogeneity, RE are used as a robustness check where between-firm variation is informative, Pooled OLS with Clustered Errors is employed for models involving time-invariant variables such as supply-chain role. Hausman and Breusch–Pagan Lagrange Multiplier (LM) tests guide estimator selection; results are consistent across specifications.

4.4.2 *Dynamic specification and endogeneity correction.* To address possible reverse causality—where leverage might influence supply-chain position—dynamic models are estimated using lagged dependent variables. The preferred specification is:

$$\text{Leverage}_{it} = \rho \text{Leverage}_{i,t-1} + \beta X_{it} + \lambda_t + \mu_i + \epsilon_{it}$$

It is estimated via the Arellano–Bover/Blundell–Bond System GMM method using lagged levels and differences of Leverage as instruments. Where sample size limits GMM efficiency, an alternative lagged-independent-variable FE model serves as a robustness check.

Hansen ($p > 0.10$) and Arellano–Bond (AR(2)) ($p > 0.20$) tests confirm the absence of instrument invalidity and second-order serial correlation. The inclusion of $\rho \text{Leverage}_{i,t-1}$ captures capital-structure persistence, addressing the primary endogeneity concern.

4.4.3 *Structural breaks and temporal shocks.* Industry cycles and macro shocks are controlled through crisis dummy variables already in the dataset: crisis08 (2008–2009), tradewar (2018–2019), and covid2021 (2020–2022). These are entered both as stand-alone controls and as interaction terms with supply-chain position to test whether leverage behaviour shifts during major disruptions. Including these internally generated dummies effectively captures regime changes without relying on external data.

4.4.4 *Robustness and diagnostics.* All regressions employ firm-clustered robust standard errors. Multicollinearity tests ($\text{VIF} < 5$) and model-selection diagnostics are reported in [Supplementary Table A4](#). Alternative leverage definitions and integration measures yield consistent results ([Supplementary Table A3](#)). Collectively, these models demonstrate that the findings are not artifacts of estimator choice or outlier influence.

4.5 Addressing endogeneity: identification strategy and remaining limitations

Endogeneity is a central methodological concern in empirical capital-structure research, primarily arising through (1) reverse causality between leverage and organizational decisions, (2) omitted time-varying heterogeneity, and (3) potential self-selection into supply-chain segments. Because reviewers emphasized the need for explicit treatment of endogeneity, we adopt a multi-layered identification strategy that combines fixed-effects estimation, correlated RE, lagged dependent variable models, and System GMM. Each component addresses a different endogeneity channel, consistent with established practice in corporate-finance panel econometrics.

Reverse causality may occur if leverage affects firms' abilities to expand or contract functional roles or segmental integration. We mitigate this concern in two ways. First, firm FE absorb all time-invariant drivers of supply-chain position, including technological capabilities, path-dependent production investments, and long-term contract structures. As discussed in [Supplementary Table A5](#), supply-chain roles in semiconductors are structurally rigid and slow to evolve due to sunk costs and coordination requirements, making reverse

causality empirically limited. Second, we estimate a lagged-dependent-variable fixed-effects (FE-LDV) model, which captures leverage persistence and isolates short-term fluctuations from long-run drivers. The significant coefficient on lagged leverage (≈ 0.25) confirms moderate persistence, consistent with capital-structure adjustment theories.

Omitted variable bias is addressed through (1) year FE to absorb macroeconomic and policy shocks, (2) crisis dummies for the 2008–2009 the Global Financial Crisis (2008–2009), the 2018–2019 trade tensions, and COVID-19 (2020–2022), and (3) a correlated random effects (CRE/Mundlak) specification that augments the random-effects model with firm-level means of all time-varying covariates, allowing unobserved heterogeneity to correlate explicitly with regressors.

Finally, to address potential simultaneity between leverage and other covariates, we estimate a dynamic panel model using the two-step System GMM estimator (Arellano–Bover/Blundell–Bond), following best practice for corporate-finance panels with moderate T and large N. Lagged levels and differences of leverage serve as internal instruments, while firm fundamentals and crisis dummies are treated as predetermined or exogenous. Diagnostic tests support the specification: AR(2) tests indicate no second-order serial correlation ($p > 0.20$), and the Hansen test provides no evidence of instrument invalidity ($p > 0.10$). The results remain directionally consistent with static models ([Supplementary Table A6](#)), suggesting that endogeneity does not drive the substantive findings.

We acknowledge that supply-chain roles cannot be instrumented using credible external instruments due to the path-dependent, technology-intensive nature of semiconductor production. Propensity-score matching is similarly inappropriate because functional roles are structural characteristics rather than treatment states. For these reasons, our approach relies on methods widely accepted in modern corporate finance—FE, CRE, FE-LDV, and System GMM—to address endogeneity within the constraints of real-world value-chain rigidity.

4.6 Model diagnostics and statistical tests

To reinforce empirical transparency, we report all major diagnostic statistics recommended for panel-data model selection and multicollinearity assessment.

4.6.1 Correlation matrix. [Supplementary Table A3](#) presents Pearson correlations for all main variables. No pairwise correlation exceeds 0.55, suggesting limited risk of inflated variance or confounding between predictors.

4.6.2 Variance inflation factors (VIF). As reported in [Supplementary Table A4](#), all variance inflation factors (VIF) values fall well below the conservative threshold of 5 (mean VIF = 1.53), indicating that multicollinearity is not a concern.

4.6.3 Hausman test. We perform a Hausman specification test to adjudicate between fixed-effects and random-effects models. The test yields $\chi^2 = 60.0$ ($p < 0.001$), indicating that the FE estimator is preferred for within-firm inference and justifying our reliance on FE for causal interpretation.

4.6.4 Breusch–Pagan LM test. Breusch–Pagan LM Test. A Breusch–Pagan LM test rejects pooled OLS in favour of a random-effects structure. The Breusch–Pagan LM test for RE strongly rejects pooled OLS ($\chi^2 = 271.31$, $p < 0.001$), confirming the appropriateness of a panel-data specification.

4.6.5 Serial correlation and instrument validity (dynamic models). System GMM diagnostics confirm the appropriateness of the specification (AR(2) $p > 0.20$, Hansen $p > 0.10$). These results support the conclusion that dynamic endogeneity is sufficiently addressed.

Collectively, these diagnostic results provide strong evidence that the empirical models are well-specified, statistically sound, and robust to multicollinearity and structural misclassification.

5. Results

5.1 Descriptive patterns and diagnostic evidence

Table 2 presents descriptive statistics for leverage, supply-chain roles, segmental integration, and firm-level covariates. The distribution of Net D/E is highly skewed, with extreme values concentrated among upstream equipment and wafer-fabrication firms—consistent with high capital intensity and long payback horizons. Variability in profitability and market valuation reflects pronounced cyclical and technological shocks throughout the sample period.

The correlation matrix (Supplementary Table A3) confirms that multicollinearity is not a concern; the highest correlation among regressors is modest. VIF values (Supplementary Table A4) fall well below conventional thresholds (mean VIF = 1.53). Diagnostic tests validate the panel structure: the Breusch–Pagan LM test rejects pooled OLS, and the Hausman test clearly favours FE over RE. These diagnostics confirm the suitability of FE, CRE, and dynamic approaches used in subsequent sections.

5.2 Baseline regression results (H1)

Supplementary Table A5 reports the baseline OLS, RE, FE, and correlated random-effects (CRE/Mundlak) estimations. The results consistently support H1, which posits that supply-chain functional role is a primary determinant of leverage.

Across pooled OLS, RE, and CRE specifications. Midstream firms exhibit significantly lower leverage relative to upstream firms. Downstream firms show higher leverage, albeit with smaller magnitudes than upstream firms. These patterns align with structural logic: upstream segments (equipment, wafers) are capital-intensive and dependent on long-term borrowing, whereas midstream design and logic-production activities rely primarily on intangible assets and are less conducive to debt financing.

In the FE model, time-invariant functional roles are absorbed, but the coefficients on time-varying controls (ROA, P/B, Age, and Size) match expected signs and reinforce the economic logic underlying the pooled/RE/CRE results.

Overall, Supplementary Table A5 provides strong baseline support that functional specialization—rather than geographic region or integration level—is the main structural determinant of leverage.

5.3 Headquarters region and institutional context (H2)

H2 predicts that upstream firms headquartered in East Asia exhibit higher leverage due to institutional financing advantages. However, across all specifications in Supplementary Table A5, the East Asia coefficient is small and statistically insignificant once functional role and firm-level fundamentals are controlled.

This pattern indicates that regional effects—while meaningful in broader strategic-coupling contexts—do not independently drive leverage in the presence of structural supply-chain determinants. The null findings for H2 are further confirmed in the sub-period (Supplementary Table A8) and size-split analyses (Supplementary Table A9), which show no systematic shift in leverage patterns for East Asian firms during major institutional or geopolitical cycles.

5.4 Organizational integration and leverage (H3)

H3 posits that integrated firms (segmentcount > 1) rely less on external debt due to internal capital-market advantages. However, across OLS, RE, CRE, FE-LDV, and System GMM estimates, the coefficient on segmentcount remains small and statistically insignificant. The negative sign observed in some models is not stable across both static and dynamic specifications.

Taken together, these results indicate that, in the semiconductor sector, functional specialization appears to dominate integration-based financial synergies. Integration may

introduce managerial complexity and investment heterogeneity that offset internal-financing benefits, explaining why H3 is not empirically supported.

5.5 Dynamic specifications and endogeneity tests

5.5.1 FE with lagged dependent variable (FE-LDV). [Supplementary Table A6](#) reports the FE-LDV model that incorporates lagged Net D/E to capture leverage persistence. The lagged coefficient is positive but moderate, indicating only limited persistence once firm and year effects are controlled.

Crucially, coefficients on ROA, P/B, and size remain stable relative to [Supplementary Table A5](#), demonstrating that baseline findings are not artifacts of omitted dynamic processes. The inclusion of lagged leverage does not materially alter the interpretation of H1–H3.

5.5.2 System GMM dynamic panel model. [Supplementary Table A7](#) presents results from the two-step System GMM estimator with Windmeijer-corrected standard errors. This model addresses reverse causality between leverage and profitability, persistence in leverage, and omitted time-varying institutional influences.

Key findings are as follows. Lagged Net D/E remains positive but modest in magnitude, confirming limited but non-negligible persistence. Functional roles maintain the same directional patterns as in [Supplementary Table A5](#). ROA retains a negative and significant association with leverage. System GMM diagnostics confirm the validity of the specification. The Arellano–Bond tests do not detect serial correlation in first-differenced errors (AR(1): $z = -0.75$, $p = 0.454$; AR(2): $z = -0.01$, $p = 0.992$), and the Hansen test of overidentifying restrictions does not reject instrument validity ($\chi^2(17) = 22.63$, $p = 0.162$). Difference-in-Hansen tests further confirm the exogeneity of the level-equation GMM instruments ($\chi^2(1) = 0.03$, $p = 0.871$). System GMM thus corroborates the core structural findings and addresses the potential endogeneity channels identified in the methodology.

5.6 Robustness tests

5.6.1 Sub-period stability (structural breaks). [Supplementary Table A8](#) presents regressions split into three major industry periods:

- (1) 2004–2010 (pre-reshoring and pre-memory-cycle shift)
- (2) 2011–2016 (mobile era, early U.S.–China competition)
- (3) 2017–2022 (trade war + COVID + subsidy-driven reconfiguration)

Across all periods, ROA remains negative, P/B remains positive, and functional-role patterns remain directionally consistent.

These results confirm that the structural determinants for H1 hold across technological and geopolitical cycles.

5.6.2 Size-split robustness. [Supplementary Table A9](#) divides firms at the median asset size. The coefficients on profitability, valuation, and supply-chain roles remain consistent across small and large firms. Larger firms exhibit a stronger negative age–leverage relationship, consistent with lifecycle financing dynamics, but this does not affect the main hypotheses.

5.6.3 Outlier-robustness tests. Given extreme outliers in sales growth and margin variables, [Supplementary Table A10](#) reports FE regressions after winsorizing at the 5–95 percentile, trimming the top 1%, excluding observations with implausibly large profitability swings.

Coefficient signs and significance remain stable across all three specifications. The robustness of [Supplementary Table A5](#)'s results under these conditions demonstrates that extreme values do not drive the findings.

5.6.4 Rolling-window coefficient stability. [Supplementary Table A11](#) reports 5-year rolling FE regressions to assess temporal stability. Across all windows, ROA remains consistently negative, P/B remains positive, and functional-role differences reappear whenever supply-chain variation is sufficient within the window. Confidence intervals widen during the post-

2018 volatility period, but signs remain stable. These findings indicate persistent structural relationships rather than period-specific artifacts.

5.7 Summary of findings

Together, all the outputs provide convergent evidence:

- (1) **H1** supported: Functional role is the primary determinant of leverage.
- (2) **H2** not supported: East Asian institutional context does not independently raise leverage once structural and firm-level controls are applied.
- (3) **H3** not supported: Organizational integration does not systematically reduce leverage.

The results remain stable across FE, CRE, FE-LDV, System GMM, sub-period splits, size splits, outlier removal, and rolling-window tests. Capital structure in semiconductors is thus best understood as a structural function of supply-chain positioning, rather than region or organizational scope.

6. Discussion

This study examined how semiconductor firms' capital structures are influenced by their functional roles in global value chains, their institutional embeddedness – particularly within East Asian policy regimes – and their organizational integration across production stages. The results advance our understanding of capital structure formation by situating financial decision-making within a multi-level framework that includes industrial positioning, national institutional systems, and firm-level governance.

Our findings offer strong support for the hypothesis that upstream firms maintain significantly higher leverage than midstream and downstream firms. This outcome aligns with the trade-off theory (Myers, 1984; Kraus and Litzenberger, 1973) and supports the assertion that fixed capital intensity is a critical driver of external debt usage. The structural logic is especially clear in the semiconductor sector, where wafer fabs and production equipment suppliers incur massive upfront investment costs, long payback periods, and substantial sunk costs (Fan *et al.*, 2012; Coe and Yeung, 2015). Our results provide empirical confirmation that functional specialization – an oft-overlooked factor in corporate finance – plays a decisive role in shaping firm-level financial policy (Sturgeon and Kawakami, 2011; Gereffi *et al.*, 2005).

However, we find no evidence that institutional support in East Asia leads to higher leverage among upstream firms, which is contrary to expectations derived from strategic coupling theory in the GPN literature (Yeung, 2009, 2022). This finding complicates the conventional wisdom that East Asian developmental states, through tools such as subsidized credit, R&D co-investment, and export facilitation, promote debt-led industrial expansion (Wong, 2011; Mathews, 2006; Breznitz, 2007). One possible explanation is that institutional support may manifest through equity-based mechanisms, including sovereign wealth injections, state equity stakes, or guaranteed procurement contracts, which reduce the need for leverage while still providing financial security (Allen *et al.*, 2005; Chang, 2003). Moreover, the effectiveness of strategic coupling may differ across countries – China's state-capitalist model, for instance, varies significantly from Taiwan's hybrid private-public innovation ecosystem – leading to an aggregation bias in our regional dummy variable (Haggard, 2018; Hall and Soskice, 2001).

The third hypothesis – that vertically integrated firms exhibit lower leverage due to internal capital markets – was also not supported. While internal capital markets are theorized to reduce financing frictions and allocate capital more efficiently (Stein, 1997; Khanna and Yafeh, 2007), our findings suggest that the benefits of functional integration may be neutralized by organizational complexities and coordination costs (Rajan *et al.*, 2000). This is particularly salient in semiconductors, where vertically integrated firms must navigate technological

complexity, diverse operating cycles, and product-market heterogeneity (Macher and Mowery, 2004). The null result may also reflect a bounded variation in integration: most firms in our dataset are either narrowly specialized or operate across only two adjacent segments, limiting the detection of leverage-reducing advantages from broader diversification.

More broadly, these results support a growing movement in financial research that emphasizes the spatial and functional embeddedness of firms as determinants of strategy and performance (Coe and Yeung, 2015; Rugman and Verbeke, 2001; Luo and Tung, 2007). The evidence points to a nuanced reality: capital structure is shaped not only by standard firm-level variables (profitability, size, etc.) but also by a firm's position in the global division of labour, the institutional scaffolding in which it operates, and the organizational boundaries it constructs to manage technological uncertainty and scale economies.

Overall, the findings contribute to international business and corporate-finance research by showing that supply-chain embeddedness acts as a structural determinant of capital structure. Rather than viewing financing decisions as purely endogenous or firm-specific, this study highlights how strategic segmentation within global production networks constrains and channels financial behaviour. The results suggest that enduring technological architectures—not short-term financial constraints—anchor firms' financial strategies over time.

For practitioners, particularly chief financial officers and financial strategists in high-tech manufacturing, these findings underscore the need to align financing strategy with capital intensity and cash flow structure specific to the firm's functional role. For example, fabless firms may benefit from maintaining financial agility through equity-based funding, while upstream firms should optimize long-term debt to stabilize capital-intensive operations. The absence of significant regional leverage effects suggests that cross-border comparisons of capital structure must go beyond institutional generalizations and account for sector-specific financial architectures.

From a policy standpoint, our findings offer important implications. Governments in East Asia and beyond – investing heavily in semiconductor self-sufficiency and resilience – must recognize that firms do not uniformly respond to institutional support through increased debt financing. Instead, a diverse financing toolkit, including public-private partnerships, innovation grants, equity funding, and state-backed credit guarantees, may better align with the sector's varied capital structures. Moreover, support programs may need to be targeted by function, rather than firm nationality or scale alone, to achieve desired industrial outcomes.

Finally, our study reinforces the value of cross-disciplinary frameworks that integrate corporate finance, institutional economics, and GVC theory. Future research may build on this approach to explore how other sectors – such as electric vehicles, clean energy, or biotechnology – navigate similar tensions between functional specialization, institutional embeddedness, and organizational design in financial decision-making processes.

7. Limitations and future research

This study is subject to several limitations that open avenues for future research. First, while the dataset offers broad coverage of the global semiconductor sector, it is limited to publicly listed firms, potentially excluding smaller private firms or state-owned enterprises that may follow different financial logics. Future studies could incorporate more granular firm types, particularly in state-capitalist economies like China or in the SF segment, where startups often rely on venture capital rather than traditional debt.

Second, the operationalization of East Asian institutional embeddedness through a regional dummy may obscure important intra-regional variation. For instance, Japan's financial architecture, dominated by bank-centred systems and cross-shareholding, contrasts sharply with Taiwan's innovation-driven, equity-oriented model. Country-specific institutional indicators or policy variables – such as sector-specific credit subsidies or export insurance – could improve the precision of institutional measurement.

Third, our proxies for segmental integration do not fully capture the strategic or contractual nuances of internal capital markets. For example, integration may vary in degree (e.g. equity stakes, long-term contracts, or complete acquisition) and in scope (horizontal vs. vertical). Qualitative case studies or mixed-methods approaches could provide richer insights into how integration affects internal financing capacity and capital structure.

Fourth, the study does not account for ownership structure, which may mediate the relationship between institutional context and financial strategy. Family-owned, state-owned, and foreign-invested firms may respond differently to institutional environments and external financing constraints. Incorporating ownership variables could improve the explanatory power of future models.

Finally, while this paper focuses on the semiconductor sector, the theoretical framework is applicable to other strategically important, fragmented, and capital-intensive sectors – such as renewable energy, electric vehicles, and biotechnology. Comparative research across sectors and regions would help assess the generalizability of the findings and refine the institutional and functional determinants of capital structure in globally embedded industries.

8. Conclusion

This study investigates how the capital structure decisions of semiconductor firms are shaped by their position in global value chains, their institutional context – particularly in East Asia – and their degree of organizational integration. Drawing on a proprietary panel dataset of nearly 5,000 firm-year observations spanning 2004 to 2022, the analysis advances a multi-level perspective that integrates theories from corporate finance, institutional economics, and GPN studies.

The findings reveal that functional role within the supply chain is the most significant determinant of leverage. Upstream firms engaged in capital-intensive activities such as fabrication and equipment manufacturing exhibit systematically higher debt ratios than downstream firms. This pattern supports the theoretical expectation that fixed asset intensity and long investment cycles increase the need for external debt (Myers, 1984; Rajan and Zingales, 1995; Fan *et al.*, 2012).

Contrary to our second hypothesis, the study finds no evidence that East Asian institutional support uniformly increases firm leverage among upstream players. While East Asian developmental states are often characterized by debt-facilitating industrial policy (Wong, 2011; Mathews, 2006), our results suggest that such support may take more diverse forms – such as equity investment, subsidies, or procurement guarantees – that reduce reliance on debt. This null effect contributes to a more nuanced understanding of strategic coupling in the GPN framework (Yeung, 2009), demonstrating that institutional embeddedness does not necessarily manifest in higher leverage.

The third hypothesis – that functionally integrated firms exhibit lower leverage due to internal capital markets – is also not supported. This may reflect the complex trade-offs of vertical integration in the semiconductor sector, where operational scale is accompanied by coordination challenges and heterogeneous financial needs across segments (Macher and Mowery, 2004; Rajan *et al.*, 2000). The findings call for greater empirical attention to the contingent nature of financial synergies within multi-segment organizations.

From a theoretical standpoint, the study advances a contextualized view of capital structure, one that resists one-size-fits-all prescriptions and instead emphasizes institutional, functional, and organizational contingencies. It contributes to the small but growing literature that seeks to bridge international business and corporate finance by embedding firm behaviour in global production structures and national financial architectures (Coe and Yeung, 2015; Rugman and Verbeke, 2001).

Practically, the results provide guidance to financial executives in technology industries who must align funding strategies with operational roles and capital expenditure cycles. In capital-intensive upstream functions, optimizing debt maturity and managing liquidity risk are

essential. Meanwhile, downstream and midstream firms may benefit from more equity-based strategies to preserve agility in volatile markets.

For policymakers, the study highlights the importance of tailoring industrial financing mechanisms to firm-level heterogeneity. A singular focus on debt provision may not suit all firms, even within strategic sectors like semiconductors. Instead, flexible instruments – such as convertible debt, equity stakes, or public co-investment – can be more effective in supporting national competitiveness without distorting firm-level financial health.

Future research could extend this framework by examining ownership structure, cross-border listing, or sovereign investment patterns, as well as exploring similar dynamics in other industries undergoing functional fragmentation and geopolitical reordering, such as green energy, pharmaceuticals, or aerospace. Methodologically, comparative case studies and multi-level modelling could further reveal how financial strategies are negotiated between global corporate imperatives and national institutional logics.

In sum, this paper underscores the need for a contextual, multi-theoretical approach to understanding firm finance in strategic global industries. The semiconductor sector, at the frontier of technological change and international political economy, serves as a revealing case for how financial strategies are embedded in broader economic and institutional architectures.

Supplementary material

The supplementary material for this article can be found online.

References

- Allen, F., Qian, J. and Qian, M. (2005), “Law, finance, and economic growth in China”, *Journal of Financial Economics*, Vol. 77 No. 1, pp. 57-116, doi: [10.1016/j.jfineco.2004.06.010](https://doi.org/10.1016/j.jfineco.2004.06.010).
- Barney, J. (1991), “Firm resources and sustained competitive advantage”, *Journal of Management*, Vol. 17 No. 1, pp. 99-120, doi: [10.1177/014920639101700108](https://doi.org/10.1177/014920639101700108).
- Beck, T., Demirgüç-Kunt, A. and Maksimovic, V. (2008), “Financing patterns around the world: are small firms different?”, *Journal of Financial Economics*, Vol. 89 No. 3, pp. 467-487, doi: [10.1016/j.jfineco.2007.10.005](https://doi.org/10.1016/j.jfineco.2007.10.005).
- Berger, P.G. and Ofek, E. (1995), “Diversification’s effect on firm value”, *Journal of Financial Economics*, Vol. 37 No. 1, pp. 39-65, doi: [10.1016/0304-405x\(94\)00798-6](https://doi.org/10.1016/0304-405x(94)00798-6).
- Blundell, R. and Bond, S. (1998), “Initial conditions and moment restrictions in dynamic panel data models”, *Journal of Econometrics*, Vol. 87 No. 1, pp. 115-143, doi: [10.1016/s0304-4076\(98\)00009-8](https://doi.org/10.1016/s0304-4076(98)00009-8).
- Breznitz, D. (2007), *Innovation and the State: Political Choice and Strategies for Growth in Israel, Taiwan, and Ireland*, Yale University Press, New Haven, CT.
- Chang, H.J. (2003), “State-owned enterprise reform”, in *Rethinking Development Economics*, Anthem Press, London.
- Chung, C.N. and Luo, X. (2008), “Institutional logics or agency costs: the influence of corporate governance models on business group restructuring in emerging economies”, *Organization Science*, Vol. 19 No. 5, pp. 766-784, doi: [10.1287/orsc.1070.0342](https://doi.org/10.1287/orsc.1070.0342).
- Coe, N.M. and Yeung, H.W.C. (2015), *Global Production Networks: Theorizing Economic Development in an Interconnected World*, Oxford University Press, Oxford.
- De Jong, A., Kabir, R. and Nguyen, T.T. (2008), “Capital structure around the world: the roles of firm- and country-specific determinants”, *Journal of Banking and Finance*, Vol. 32 No. 9, pp. 1954-1969, doi: [10.1016/j.jbankfin.2007.12.034](https://doi.org/10.1016/j.jbankfin.2007.12.034).
- Elshaarawy, R. and Ezzat, R.A. (2023), “Global value chains, financial constraints, and innovation”, *Small Business Economics*, Vol. 61 No. 1, pp. 223-257, doi: [10.1007/s11187-022-00685-8](https://doi.org/10.1007/s11187-022-00685-8).
- Ernst, D. (2005), “Complexity and internationalization of innovation: why is chip design moving to Asia?”, *International Journal of Innovation Management*, Vol. 9 No. 1, pp. 47-73.

- Fan, J.P., Titman, S. and Twite, G. (2012), "An international comparison of capital structure and debt maturity choices", *Journal of Financial and Quantitative Analysis*, Vol. 47 No. 1, pp. 23-56, doi: [10.1017/s0022109011000597](https://doi.org/10.1017/s0022109011000597).
- Frank, M.Z. and Goyal, V.K. (2003), "Testing the pecking order theory of capital structure", *Journal of Financial Economics*, Vol. 67 No. 2, pp. 217-248, doi: [10.1016/s0304-405x\(02\)00252-0](https://doi.org/10.1016/s0304-405x(02)00252-0).
- Frank, M.Z. and Goyal, V.K. (2009), "Capital structure decisions: which factors are reliably important?", *Financial Management*, Vol. 38 No. 1, pp. 1-37, doi: [10.1111/j.1755-053x.2009.01026.x](https://doi.org/10.1111/j.1755-053x.2009.01026.x).
- Gereffi, G., Humphrey, J. and Sturgeon, T. (2005), "The governance of global value chains", *Review of International Political Economy*, Vol. 12 No. 1, pp. 78-104, doi: [10.1080/09692290500049805](https://doi.org/10.1080/09692290500049805).
- Haggard, S. (2018), *Developmental States*, Cambridge University Press, Cambridge.
- Hall, P.A. and Soskice, D. (2001), "An introduction to varieties of capitalism", in Hall, P.A. and Soskice, D. (Eds), *Varieties of Capitalism: the Institutional Foundations of Comparative Advantage*, Oxford University Press, London.
- Harris, M. and Raviv, A. (1991), "The theory of capital structure", *The Journal of Finance*, Vol. 46 No. 1, pp. 297-355, doi: [10.1111/j.1540-6261.1991.tb03753.x](https://doi.org/10.1111/j.1540-6261.1991.tb03753.x).
- Hobday, M. (2003), "Innovation in Asian industrialization: a Gerschenkronian perspective", *Oxford Development Studies*, Vol. 31 No. 3, pp. 293-314, doi: [10.1080/1360081032000111715](https://doi.org/10.1080/1360081032000111715).
- Khanna, T. and Palepu, K. (2000), "The future of business groups in emerging markets: long-run evidence from Chile", *Academy of Management Journal*, Vol. 43 No. 3, pp. 268-285, doi: [10.2307/1556395](https://doi.org/10.2307/1556395).
- Khanna, T. and Yafeh, Y. (2007), "Business groups in emerging markets: paragons or parasites?", *Journal of Economic Literature*, Vol. 45 No. 2, pp. 331-372, doi: [10.1257/jel.45.2.331](https://doi.org/10.1257/jel.45.2.331).
- Kraus, A. and Litztenberger, R.H. (1973), "A state-preference model of optimal financial leverage", *The Journal of Finance*, Vol. 28 No. 4, pp. 911-922, doi: [10.2307/2978343](https://doi.org/10.2307/2978343).
- Lam, H.K. and Zhan, Y. (2021), "The impacts of supply chain finance initiatives on firm risk: evidence from service providers listed in the US", *International Journal of Operations and Production Management*, Vol. 41 No. 4, pp. 383-409, doi: [10.1108/ijopm-07-2020-0462](https://doi.org/10.1108/ijopm-07-2020-0462).
- Langlois, R.N. and Robertson, P.L. (1995), *Firms, Markets and Economic Change: a Dynamic Theory of Business Institutions*, Routledge, London.
- Luo, Y. and Tung, R.L. (2007), "International expansion of emerging market enterprises: a springboard perspective", *Journal of International Business Studies*, Vol. 38 No. 4, pp. 481-498, doi: [10.1057/palgrave.jibs.8400275](https://doi.org/10.1057/palgrave.jibs.8400275).
- Macher, J.T. and Mowery, D.C. (2004), "Vertical specialization and industry structure in high technology industries", *Business History Review*, Vol. 78 No. 3, pp. 473-507.
- Maksimovic, V. and Phillips, G. (2002), "Do conglomerate firms allocate resources inefficiently across industries?", *The Journal of Finance*, Vol. 57 No. 2, pp. 721-767, doi: [10.1111/1540-6261.00440](https://doi.org/10.1111/1540-6261.00440).
- Mathews, J.A. (2006), "Dragon multinationals: new players in 21st century globalization", *Asia Pacific Journal of Management*, Vol. 23 No. 1, pp. 5-27, doi: [10.1007/s10490-006-6113-0](https://doi.org/10.1007/s10490-006-6113-0).
- Myers, S. (1984), "The capital structure puzzle", *The Journal of Finance*, Vol. 39 No. 3, pp. 574-592, doi: [10.2307/2327916](https://doi.org/10.2307/2327916).
- Myers, S.C. and Majluf, N.S. (1984), "Corporate financing and investment decisions when firms have information that investors do not have", *Journal of Financial Economics*, Vol. 13 No. 2, pp. 187-221, doi: [10.1016/0304-405x\(84\)90023-0](https://doi.org/10.1016/0304-405x(84)90023-0).
- Porta, R.L., Lopez-de-Silanes, F., Shleifer, A. and Vishny, R.W. (1998), "Law and finance", *Journal of Political Economy*, Vol. 106 No. 6, pp. 1113-1155, doi: [10.1086/250042](https://doi.org/10.1086/250042).
- Rajan, R.G. and Zingales, L. (1995), "What do we know about capital structure? Some evidence from international data", *The Journal of Finance*, Vol. 50 No. 5, pp. 1421-1460, doi: [10.1111/j.1540-6261.1995.tb05184.x](https://doi.org/10.1111/j.1540-6261.1995.tb05184.x).

- Rajan, R.G., Servaes, H. and Zingales, L. (2000), "The cost of diversity: the diversification discount and inefficient investment", *The Journal of Finance*, Vol. 55 No. 1, pp. 35-80, doi: [10.1111/0022-1082.00200](https://doi.org/10.1111/0022-1082.00200).
- Rugman, A.M. and Verbeke, A. (2001), "Subsidiary-specific advantages in multinational enterprises", *Strategic Management Journal*, Vol. 22 No. 3, pp. 237-250, doi: [10.1002/smj.153](https://doi.org/10.1002/smj.153).
- SIA (2023), "2022 State of the U.S. semiconductor industry, semiconductor industry association", available at: https://www.semiconductors.org/wp-content/uploads/2022/11/SIA_State-of-Industry-Report_Nov-2022.pdf
- Stein, J.C. (1997), "Internal capital markets and the competition for corporate resources", *The Journal of Finance*, Vol. 52 No. 1, pp. 111-133, doi: [10.1111/j.1540-6261.1997.tb03810.x](https://doi.org/10.1111/j.1540-6261.1997.tb03810.x).
- Sturgeon, T. and Kawakami, M. (2011), "Global value chains in the electronics industry", in *Global Value Chains in a Postcrisis World*, World Bank, Washington.
- Wernerfelt, B. (1984), "A resource-based view of the firm", *Strategic Management Journal*, Vol. 5 No. 2, pp. 171-180, doi: [10.1002/smj.4250050207](https://doi.org/10.1002/smj.4250050207).
- Windmeijer, F. (2005), "A finite sample correction for the two-step GMM estimator in dynamic panel data models", *Journal of Econometrics*, Vol. 126 No. 1, pp. 25-51, doi: [10.1016/j.jeconom.2004.02.005](https://doi.org/10.1016/j.jeconom.2004.02.005).
- Wong, J. (2011), *Betting on Biotech: Innovation and the Limits of Asia's Developmental State*, Cornell University Press, New York.
- Yeung, H.W.C. (2009), "Transnationalizing entrepreneurship: a critical agenda for economic geography", *Progress in Human Geography*, Vol. 33 No. 2, pp. 210-235, doi: [10.1177/0309132508096032](https://doi.org/10.1177/0309132508096032).
- Yeung, H.W.C. (2022), "Explaining geographic shifts of chip making toward East Asia and market dynamics in semiconductor global production networks", *Economic Geography*, Vol. 98 No. 3, pp. 272-298, doi: [10.1080/00130095.2021.2019010](https://doi.org/10.1080/00130095.2021.2019010).
- Yeung, H.W.C., Huang, J. and Xing, Y. (2023), "From fabless to fabs everywhere? Semiconductor global value chains in transition", in *Global Value Chain Development Report 2023: Resilient and Sustainable Gvcs in Turbulent Times*, World Trade Organization & Asian Development Bank, Chapter 4.

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