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Research Article

FINANCIAL RISK PROFILES IN TECHNOLOGY-INTENSIVE MINERAL DOWNSTREAMING: EVIDENCE FROM INDONESIAN MINING FIRMS

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ABSTRACT

Background: Technology-intensive mineral downstreaming places substantial demands on operating cash generation, investment capacity, and financing flexibility; however, firms may experience different financial exposures.
Purpose: This study compares firm-level financial risks and identifies resilience patterns among Indonesian listed mining companies from 2018 to 2025.
Design/methodology/approach: This exploratory, non-causal descriptive-comparative study analyzes 72 firm-year observations from nine firms. Five accounting-based measures are examined separately: operating cash flow (OCF) margin volatility, negative OCF frequency, negative free cash flow (FCF) frequency, average capital expenditure (CAPEX) intensity, and average leverage ratio.
Findings/Results: Four descriptive patterns emerge: relatively resilient cash generators, investment-sensitive but operating-cash-resilient firms, multidimensional elevated-risk firms, and firms with persistent cash flow and financing vulnerability. Negative FCF accompanying positive OCF and intensive investment differs from repeated negative OCF accompanied by high leverage. Profiles vary even within the same downstreaming-exposure category.
Conclusion: Downstreaming does not imply a uniform financial trajectory. Resilience must be assessed through the joint consideration of cash-generating stability, investment-related cash pressure, and financing exposure.
Originality/value: This study offers a reproducible, multidimensional descriptive framework that distinguishes investment-related cash absorption from persistent operating and financing weaknesses without attributing causal effects to downstreaming.

ARTICLE INFO

Keywords:
cash flow, financial resilience, financial risk, mineral downstreaming, technology management

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INTRODUCTION

Critical minerals underpin energy-transition technologies and advanced manufacturing, encouraging resource-rich countries to expand domestic refining and processing. Indonesia has pursued this transformation particularly in nickel and related battery and industrial supply chains. Existing research documents growing processing capacity and investment, alongside uneven distribution of downstreaming benefits and challenges in domestic value capture (Schröder & Iwasaki, 2024; Warburton, 2024; Firmanto et al. 2025; Vivoda et al. 2026).

Downstreaming is more than just physical capacity expansion. Processing depends on reliable energy, infrastructure, technical knowledge, qualified products, financing, and market access; the relevant investment conditions differ in their configuration from those of extraction alone (Vivoda, 2026). This system dependence makes downstreaming a financial and organizational transformation, as well as a capital investment program.

Smelters and related assets require substantial cash CAPEX well before their potential operating benefits are fully realized. Financing exposure and the ability to generate OCF consequently matter as firms manage extended projects. Corporate research relates cash flow uncertainty to liquidity, financing decisions, distress

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risk, and the usefulness of accounting information for evaluating cash generation (Duong et al. 2020; Ball & Nikolaev, 2022; Keefe & Nguyen, 2023; Li et al. 2023).

Similar industrial exposure need not create similar cash flow outcomes. Some firms can invest intensively while maintaining positive OCF and moderate leverage, whereas others report temporary negative FCF after investment despite positive core cash generation, and still others suffer recurring negative OCF or financing pressure. Such differences are relevant for Indonesian mining issuers with heterogeneous commodities, stages of diversification, asset bases, and financial structures.

Two research streams inform this analysis but rarely connect in this setting. Indonesian downstreaming studies emphasize value chains, industrial policy, and uneven benefits (Schröder & Iwasaki, 2024; Warburton, 2024; Firmanto et al. 2025), while corporate accounting research relates cash flow information and volatility to financing exposure and financial vulnerability (Ball & Nikolaev, 2022; Keefe & Nguyen, 2023; Li et al. 2023). This study integrates these streams by comparing multiple audited firm-level cash flow and balance-sheet indicators during Indonesia's mineral transformation. Its novelty lies in its combination and interpretation, not in inventing new financial ratios.

This study addresses this gap by examining the financial risk profiles of nine Indonesian listed mining firms over the 2018–2025 period using audited financial statement data. Financial risk is viewed as multidimensional rather than represented by a single composite score. The analysis considers five observable indicators: operating cash flow margin volatility, frequency of negative operating cash flow, frequency of negative free cash flow, average capital expenditure intensity, and average leverage. Together, these measures capture different aspects of operating cash flow risk, downside cash exposure, capital commitment, and financing exposure. Financial resilience is consequently interpreted as the ability of a firm to maintain relatively stable cash-generating capacity and manageable financing exposure while absorbing the financial demands associated with industrial transformation. Importantly, technology intensity is treated as a contextual characteristic of downstream transformation rather than a directly measured explanatory variable.

This study asks two research questions: (RQ1) How do the sampled firms differ in operating cash flow risk, residual cash flow risk, capital commitment, and financing exposure? (RQ2) What recurring financial resilience patterns are observable across their combined indicators? Research questions, rather than directional hypotheses, are appropriate because the objective is to describe a heterogeneous, purposively selected group, not to estimate a relationship, test a policy treatment, or infer a population-level causal effect. The anticipated outputs are a transparent five-indicator firm comparison, a sample-relative visual risk matrix, and an interpretable four-pattern typology.

Three contributions follow. First, the non-weighted framework distinguishes configurations of familiar cash flow and balance-sheet indicators rather than averaging them into one risk score. Second, it differentiates investment-related negative FCF during positive OCF from repeated operating cash deficits and high leverage, showing variation within downstreaming-context groups. Third, it connects this accounting diagnosis to technology management while making clear that technological capability, investment performance, and adaptive processes are unobserved and cannot be inferred as causal drivers.

METHODS

This study uses an exploratory, quantitative descriptive-comparative design to characterize firm-level financial risk among selected Indonesian listed mining companies from 2018 to 2025. The analytical unit is the firm, summarized over eight fiscal years. The study does not estimate downstream effects, forecast distress, or compare formally defined treatment and control groups; the 72 firm-year records provide annual inputs for nine firm-level profiles. Because this study seeks to describe distinct combinations of observed exposures rather than test a specified coefficient, its guiding framework consists of research questions, not statistical hypotheses.

The multidimensional design retains five financial statement indicators separately so that operating instability, downside incidence, capital commitment, and financing exposure can be compared without using arbitrary weights. Different risk configurations may have different economic meanings, consistent with research on cash flow risk, financing choices and distress (Bates et al. 2009; Keefe & Nguyen, 2023; Li et al. 2023).

The eight-year horizon was treated as a continuous observation period. No treatment/control split or causal identification of downstream policies was attempted. Nine Indonesian Stock Exchange-listed mining issuers were purposively selected to provide heterogeneity in commodity exposure and forms of participation in the mineral downstreaming environment while retaining uninterrupted annual financial statement coverage for 2018–2025. The selection required (i) publicly available consolidated audited financial statements for all eight fiscal years; (ii) operating relevance to mining and Indonesia's industrial transformation; and (iii) identifiable revenue, net cash from operating activities, relevant cash additions to fixed assets, total assets, and total liabilities. Four firms were identified as core downstreaming cases, three as transition/diversification cases, and two as predominantly conventional mining firms (Table 1). These are qualitative contextual descriptors, not measured technology-intensity levels, matched comparison groups, or a claim that the nine companies exhaust all eligible IDX issuers. The sample supports transparent within-sample comparisons, not the statistical representation of the Indonesian mining population.

The final dataset comprises 72 firm-year observations. The sampled firms represent different levels and forms of participation in Indonesia's mining and downstreaming landscape, including firms with substantial mineral processing activities, firms undergoing downstream diversification, and predominantly upstream or conventional mining firms used as contextual comparators. The classifications in Table 1 are used only to provide industrial context and are not treated as formal treatment or control groups. The primary unit of interpretation in this study is an individual firm.

Inputs were obtained from the statement of profit or loss, statement of financial position, statement of cash flows, and accompanying notes in each issuer's audited consolidated annual financial statements for fiscal years ending on December 31, 2018, 2018 through December 31, 2025. The issuer-level reporting archives are listed in the accompanying Source Register; the relevant document type is the audited annual consolidated financial statements, not unaudited quarterly summaries. For reproducibility, a firm-year extraction register should identify fiscal year, source file, page or note, reporting currency/unit, reported or restated figure, and any CAPEX definition adjustment. Where audited comparatives were restated, the latest applicable audited restatement was preferred. Ratios and event frequencies, rather than pooled nominal amounts, are compared across firms because presentation currencies differ.

Cash CAPEX comprises cash payments to acquire or add property, plant, and equipment, or other separately identifiable fixed assets. Acquisitions of businesses, financial investments, exploration/evaluation assets, mining properties, intangibles, advances, and non-cash additions are excluded where separable; PTBA's reported combined cash-flow line for fixed assets and bearer plants is retained as an explicitly disclosed proxy. FCF is defined consistently as OCF minus this cash CAPEX measure. These definitions are narrower than total investment and should not be treated as measurements of project-specific downstreaming expenditure.

Table 1. Sample companies and downstreaming context

Company	Ticker	Main Commodity / Business	Downstreaming Context
PT Aneka Tambang Tbk	ANTM	Nickel, bauxite, gold	Core downstreaming
PT Vale Indonesia Tbk	INCO	Nickel	Core downstreaming
PT Merdeka Copper Gold Tbk	MDKA	Copper, gold, nickel	Core downstreaming
PT Timah Tbk	TINS	Tin	Core downstreaming
PT Harum Energy Tbk	HRUM	Coal, nickel	Transition / diversification
PT Alamtri Resources Indonesia Tbk (formerly PT Adaro Energy Indonesia Tbk)	ADRO	Coal, aluminium	Transition / diversification
PT Bukit Asam Tbk	PTBA	Coal	Transition / diversification
PT Indo Tambangraya Megah Tbk	ITMG	Coal	Comparator
PT Bumi Resources Tbk	BUMI	Coal	Comparator

The five indicators in Table 2 capture complementary dimensions that must be interpreted jointly: instability of the OCF-to-revenue ratio, incidence of negative OCF, incidence of negative FCF after cash CAPEX, average annual cash CAPEX-to-total-assets ratio, and average annual total-liabilities-to-total-assets ratio. OCF is net cash from operating activities, not accounting for operating income. Negative OCF and FCF frequencies use the denominator eight (full observed years). Annual OCF margins and the two balance-sheet ratios are computed before firm-level aggregation; no cross-firm currency conversion or weighted index is used. OCF margin volatility is expressed in percentage points (pp), whereas the remaining ratios and frequencies are expressed as percentages.

Operating cash flow margin is calculated as follows:
$OCF\ Margin_{it} = Operating\ Cash\ Flow_{it} / Revenue_{it}$
Free Cash Flow is calculated as:
$FCF_{it} = Operating\ Cash\ Flow_{it} - CAPEX_{it}$
Capital expenditure intensity is calculated as
$CAPEX\ Intensity_{it} = CAPEX_{it} / Total\ Assets_{it}$
Leverage is calculated as follows:
$Leverage_{it} = Total\ Liabilities_{it} / Total\ Assets_{it}$

For each firm, OCF margin volatility is the sample standard deviation of its eight annual OCF margins ($n - 1 = 7$ in the variance denominator) multiplied by 100 to report the percentage points. Negative OCF and FCF frequencies equal the number of years with values strictly below zero divided by eight, then multiplied by 100. Thus, an exact zero was not classified as a negative value. The average CAPEX intensity and average leverage are unweighted arithmetic means of eight annual ratios based on each year's reported total assets; they are not ratios of eight-year-aggregated nominal sums. Higher cash flow volatility indicates less stability, whereas frequency indicators record the incidence rather than the magnitude of deficits. These design choices are consistent with the economic relevance of cash flow risk and heterogeneity (Ball & Nikolaev, 2022; Keefe & Nguyen, 2023; Li et al. 2023).

High CAPEX intensity is not evidence of weak financial conditions; expansion can temporarily absorb cash before new assets generate benefits (Denis & Sibilkov, 2010). Conversely, high leverage is an indicator of financing exposure but does not establish insolvency or financial distress. Accordingly, CAPEX and leverage are considered jointly with operating cash generation, FCF outcomes, and volatility. Every indicator is descriptive and firm-level, with no estimated relationship to actual technology intensity.

Analysis proceeds in three stages. First, the five indicators are computed from the eight annual statements for each firm and retained separately in Table 3. Second, the nine-firm median is calculated for every indicator to provide an exclusive within-sample benchmark. Third, the observed indicator configurations are translated into a descriptive four-pattern typology, with its ex-post assignment rules stated explicitly below. No formal cluster analysis, statistical classification model, or composite risk score is applied.

Table 2. Financial Risk Indicators and Measurement

Risk Dimension	Indicator	Measurement	Interpretation
Operating cash flow risk	OCF Margin Volatility	Standard deviation of annual OCF Margin	Stability of operating cash generation
Operating downside risk	Negative OCF Frequency	Negative OCF years / 8 observed years	Frequency of operating cash shortfalls
Residual cash risk	Negative FCF Frequency	Negative FCF years / 8 observed years	Frequency of cash pressure after capital expenditure
Capital commitment	Average CAPEX Intensity	Mean of annual CAPEX / Total Assets	Intensity of investment commitment relative to the asset base
Financing exposure	Average Leverage	Mean of annual Total Liabilities / Total Assets	Dependence on liabilities to finance the asset base

A value is marked below the sample median (B), at the median (M), or above the median (A), using unrounded underlying values when available. Median equality was not considered as elevated exposure. Negative OCF at the zero median is therefore marked M, not B. The displayed percentages are rounded to two decimal places for annual-ratio aggregates and to one decimal place for event frequencies; volatility is reported to two decimal places in pp. Because the published table contains rounded summaries, classifications near the exact median should be reconfirmed against the underlying unrounded worksheet.

To make the descriptive typology reproducible, the following ex-post, sequential assignment protocol is applied to the profile values in Table 3 (earlier conditions take precedence): Pattern 4, persistent cash flow and financing vulnerability, if negative OCF frequency is at least 50% and average leverage exceeds the cross-firm median; otherwise, Pattern 3, multidimensional elevated risk, if OCF margin volatility exceeds the median, average leverage exceeds the median, and either CAPEX intensity or negative FCF frequency exceeds its median; otherwise, Pattern 2, investment-sensitive but operating-cash-resilient, if negative OCF frequency is zero, negative FCF frequency is positive, and CAPEX intensity is at least the sample median; otherwise, Pattern 1, relatively resilient cash generator. The cut-offs and sequence codified the observed nine-firm configurations after inspection and were not preregistered, externally validated, or intended for other samples without sensitivity testing.

For example, INCO recorded negative OCF in 0/8 years (0.0%) and negative FCF in 3/8 years (37.5%); its average CAPEX intensity of 8.52% exceeds the 3.90% sample median, so it meets Pattern 2 after failing Patterns 4 and 3. MDKA has above-median OCF volatility (17.17 pp), leverage (44.44%), CAPEX intensity (8.36%), and negative FCF frequency (50.0%), meeting Pattern 3. BUMI has a negative OCF in 7/8 years (87.5%) and a leverage of 61.01%, meeting Pattern 4. These are examples of frequency and assignment calculations using the summarized reported data. Full re-performance of OCF volatility and average ratios requires the underlying 72 firm-year observations and source-page extraction log; Table 3 alone cannot reproduce those aggregates.

These assignments represent the dominant descriptive profile, not mutually exclusive economic states or credit ratings. They are sensitive to the sample medians and ex-post decision thresholds. Inferential hypothesis tests were not performed because the nine firms were purposively chosen and the aim was not to generalize classification rates to a wider population or identify policy causation.

The dataset described in the source manuscript was checked against audited consolidated statements for consistency of formulas, reporting units, restatements, negative cash flow observations, and material corporate events. The present manuscript revision did not independently re-extract all 72 underlying firm-year records. Full numerical auditability, therefore, depends on retaining the annual input worksheet and a source-to-cell documentation log with the final submission. This provenance limitation does not affect the descriptive presentation of previously reported figures but restricts independent numerical re-performance from the text alone.

Table 3. Firm Level Financial Risk Profiles, 2018–2025

Firm	OCF Margin Volatility (pp)	Negative OCF Frequency	Negative FCF Frequency	Average CAPEX Intensity	Average Leverage
ANTM	2.82 pp	0.0%	12.5%	2.63%	34.26%
INCO	7.19 pp	0.0%	37.5%	8.52%	13.44%
MDKA	17.17 pp	0.0%	50.0%	8.36%	44.44%
TINS	17.49 pp	25.0%	25.0%	5.10%	54.08%
HRUM	13.27 pp	0.0%	12.5%	3.90%	23.79%
ADRO	8.97 pp	0.0%	12.5%	5.88%	34.79%
PTBA	11.12 pp	0.0%	0.0%	3.58%	37.44%
ITMG	10.27 pp	0.0%	0.0%	2.49%	24.90%
BUMI	11.00 pp	87.5%	87.5%	0.72%	61.01%
Cross-firm median	11.00 pp	0.0%	12.5%	3.90%	34.79%

Verified extreme observations and negative OCF or FCF values are retained in the baseline descriptive calculations rather than winsorized, as omitting them would suppress downside incidence and cash flow volatility. Reported corporate transactions and changes in consolidation scope are considered when interpreting the resulting multi-year averages. This approach does not adjust structural breaks.

Material differences in reporting definitions or corporate restructuring are considered when interpreting the individual firm profiles. Accordingly, the resulting classifications are intended to represent comparative financial risk characteristics over the observed period rather than permanent assessments of firm quality and solvency.

RESULTS

Firm Level Financial Risk Characteristics

Five indicators reveal substantial cross-firm heterogeneity in 2018–2025. The sample median OCF margin volatility is 11.00 pp; median negative OCF and FCF frequencies are 0.0% and 12.5%, respectively; median average CAPEX intensity and leverage are 3.90% and 34.79%, respectively. These are within-sample descriptors rather than validated distress thresholds. Firm summaries use two decimal places for volatility, CAPEX intensity, and leverage and one decimal place for downside frequencies.

An important distinction emerges between operating and residual cash flow risks. Seven of the nine firms recorded no negative operating cash flows during the eight-year observation period. Only TINS and BUMI experienced negative operating cash flows. In contrast, negative free cash flows were considerably more widespread. Only ITMG and PTBA maintained non-negative free cash flows throughout all eight years, while the remaining seven firms experienced at least one year in which operating cash generation was insufficient to cover cash capital expenditures. Across the full dataset, nine of the 72 firm-year observations had negative operating cash flows, compared with 19 observations with negative free cash flows.

ANTM combines the lowest OCF margin volatility (2.82 pp), no negative OCF, and one negative FCF year with below-median CAPEX intensity (2.63%) and leverage (34.26%). ITMG likewise records no negative OCF or FCF, with a CAPEX intensity of 2.49% and leverage of 24.90%; both have relatively limited downside exposure.

PTBA has no negative OCF or FCF, with below-median CAPEX intensity (3.58%), although its leverage (37.44%) exceeds the sample median, and its OCF margin volatility (11.12 pp) is close to the benchmark.

INCO exhibits positive OCF throughout the period and the lowest leverage (13.44%), but the highest CAPEX intensity (8.52%) and three negative FCF years. Therefore, its risk is concentrated on residual cash absorption rather than recurring operating cash deficits. ADRO combines positive OCF with above-median CAPEX intensity (5.88%), one negative FCF year, and median leverage (34.79%); its OCF volatility is below the median (8.97 pp). HRUM also records positive OCF in all years and only one negative FCF year but has above-median OCF volatility (13.27 pp), median CAPEX intensity (3.90%), and below-median leverage (23.79%).

MDKA combines positive OCF in all eight years with above-median OCF volatility (17.17 pp), CAPEX intensity (8.36%), leverage (44.44%), and four negative FCF years. Therefore, positive OCF coexists with elevated exposure in several other dimensions.

TINS shows the highest OCF volatility (17.49 pp), negative OCF and FCF in two years each, CAPEX intensity of 5.10%, and second-highest leverage (54.08%). Unlike MDKA, it also experienced negative OCF.

BUMI records negative OCF and FCF in seven of eight years, the highest leverage (61.01%), and the lowest CAPEX intensity (0.72%). Its risk is not primarily associated with unusually intensive fixed-asset expenditure; both cash flow measures will turn positive in 2025.

Emerging Financial Resilience Patterns

The five-indicator configurations yield four dominant financial resilience patterns (Table 4). The assignment protocol is provided in the Methods section; the typology is a sample-relative description rather than a formal assessment of solvency or a causal classification of downstreaming outcomes.

Table 4. Emerging Financial Resilience Patterns

Emerging Pattern	Firms	Main Empirical Characteristics
Relatively resilient cash generators	ANTM, ITMG, PTBA	No negative OCF; zero or limited negative FCF; generally low to moderate capital commitment and financing exposure
Investment-sensitive but operating-cash resilient	INCO, ADRO, HRUM	No negative OCF; capital investment creates episodic residual cash pressure; leverage remains low to moderate
Multidimensional elevated-risk profiles	MDKA, TINS	High OCF volatility combined with elevated capital commitment and/or leverage and recurring downside cash flow exposure
Persistent cash flow and financing vulnerability	BUMI	Repeated negative OCF and FCF, highest average leverage, despite very low capital expenditure intensity

Pattern 1 includes ANTM, ITMG, and PTBA, with no negative OCF and zero or limited negative FCF, despite differences in leverage and volatility. This is a comparatively resilient cash-generating profile in the sample. Pattern 2 includes INCO, ADRO, and HRUM, all of which retain positive OCF across the observation horizon while experiencing episodic residual cash pressure in association with medium or higher CAPEX intensity. INCO displayed the most recurrent negative FCF among the three. Pattern 3 includes MDKA and TINS, whose relatively high OCF volatility coincides with greater capital or financing exposure and recurring cash-flow pressure. Unlike MDKA, TINS also experiences negative OCF. Pattern 4 is represented by BUMI: repeated negative operating and free cash flows accompany the sample's highest leverage but lowest CAPEX intensity, distinguishing it from the investment-sensitive profiles.

The four core downstream firms exhibit three different patterns: ANTM is relatively resilient, INCO is investment-sensitive, and MDKA and TINS exhibit multidimensional elevated risk. The transition/diversification firms also differ (ADRO and HRUM in Pattern 2; PTBA in Pattern 1), as do the comparator firms (ITMG in Pattern 1; BUMI in Pattern 4). Thus, these nine observations do not support mechanical mapping from the contextual downstreaming category to a risk profile. Table 5 displays each firm's position relative to the within-sample indicator medians; it is a descriptive visual matrix, not a risk heatmap based on externally validated thresholds.

Data Interpretation Considerations

The firm profiles should be interpreted with several firm-specific accounting considerations in mind. ADRO underwent a major structural change in 2024 following the disposal of most of its thermal coal business, which affects the comparability of year-end assets and liabilities around that period. INCO experienced a consolidation change in 2025 when BNSI ceased to be controlled and became an associate. For PTBA, the cash flow statement from 2022 onward combines additions to fixed assets and bearer plants; thus, the combined cash outflow is used as an auditable CAPEX proxy. These observations remain in the analysis because they reflect the audited financial position of the firms, but they should be considered when interpreting the corresponding risk profiles.

The measured results show considerable heterogeneity in the five observed accounting indicators, including differences in the incidence of negative OCF versus negative FCF. Seven firms recorded no negative OCF over eight years, whereas only ITMG and PTBA avoided negative FCF. This descriptive evidence demonstrates that a single ratio cannot adequately distinguish investment-related residual cash pressure from broader operating and financing vulnerabilities. It does not demonstrate that downstreaming, technology adoption, or any particular policy caused those differences. The value of the accounting-based approach is its ability to retain the configuration of observed exposures, in line with the attention to cash flow information and firm heterogeneity emphasized by Ball and Nikolaev (2022).

In the measured profiles, INCO combines a positive OCF in all observed years with the highest CAPEX intensity (8.52%), three negative FCF years, and the lowest leverage (13.44%). ADRO and HRUM show less frequent residual cash pressure while retaining a positive annual OCF. These observations support a narrow conclusion: negative FCF can coexist with positive OCF and different leverage levels. They do not identify which downstream projects cause cash absorption or whether future investment returns will compensate for it.

Table 5. Within-sample indicator-position matrix and dominant pattern

Firm	OCF vol.	Neg. OCF	Neg. FCF	CAPEX	Leverage	Pattern
ANTM	B	M	M	B	B	1
INCO	B	M	A	A	B	2
MDKA	A	M	A	A	A	3
TINS	A	A	A	A	A	3
HRUM	A	M	M	M	B	2
ADRO	B	M	M	A	M	2
PTBA	A	M	B	B	A	1
ITMG	B	M	B	B	B	1
BUMI	M	A	A	B	A	4

Legend: B = below, M = equal to, A = above the cross-firm median; comparisons use the Table 3 displayed values as a visual aid. OCF volatility is in pp; the other indicators are percentages. An A on CAPEX signals higher investment commitment, not necessarily financial weakness. Pattern codes correspond to Table 4.

The interpretation that capital-intensive industrial transformation can require prolonged financing and operational adjustment is plausible in light of the infrastructure, technical capability, product qualification, and coordination demands described by Vivoda (2026) as follows: However, this is an interpretive lens, not an empirically tested explanation in the present study; project timing, commissioning outcomes, technology adoption, organizational learning, and investment payoffs were not measured.

MDKA and TINS exhibit high OCF volatility alongside higher capital commitment and/or leverage, with recurring downside cash flow exposure. This co-occurrence is empirically observed and does not establish financial distress. Prior corporate studies associate cash flow volatility with debt choices and distress risk (Keefe & Nguyen, 2023; Li et al. 2023), helping explain why instability becomes more informative when combined with negative cash flow or financing exposure.

BUMI illustrates a different vulnerability: the lowest CAPEX intensity occurs alongside repeated negative OCF and FCF and the highest leverage ratio. Thus, similar negative FCF signs may reflect different financial situations: investment-related residual cash absorption versus recurring operating weakness. The observation is descriptive and does not determine the cause of BUMI's cash deficit.

The observed risk patterns also cut across the broad downstreaming-context categories. Therefore, the descriptive result is narrower than a policy-effect claim: within this purposive sample, firms labelled as core, transitioning, or comparator do not share a uniform financial profile. This is consistent with research documenting uneven economic and strategic outcomes of Indonesia's downstreaming agenda (Schröder & Iwasaki, 2024; Warburton, 2024; Firmanto et al. 2025), but the earlier research primarily analyzed policy, industrial organization, and value creation rather than this specific five-indicator firm-level cash risk configuration. This study complements, rather than statistically confirms or contradicts, those findings.

From a technology-management perspective, capital deployment alone is an incomplete indicator of transformation readiness. Vivoda (2026) emphasizes that processing investment depends on the coherence of the broader industrial system, while Teece (2007) frames adaptation as the capacity to integrate and reconfigure resources. Such mechanisms may help interpret why investment and cash outcomes differ, but they are not observed in the present financial statements. Accordingly, the contribution is to identify financial conditions under which transformation takes place, not to measure dynamic capabilities or to establish their effects.

Similarly, Cohen and Levinthal's (1990) concept of absorptive capacity provides a potential explanation for the differing abilities to assimilate technological and organizational knowledge. The data here contain no direct measure of absorptive capacity, employee skills, or technical processes. Hence, any connection between the observed financial profiles and organizational learning should be presented as a hypothesis for future research rather than as an established finding.

This study also uses financial resilience in a deliberately limited sense. Duchek (2020) conceptualizes organizational resilience as a broader capacity to anticipate, cope, and adapt, while the present study observes only selected accounting-based manifestations: operating cash stability, downside incidence, capital absorption, and leverage. A favorable profile does not establish organizational resilience, creditworthiness, or technological readiness. This bounded definition avoids equating the absence of recorded negative OCF with comprehensive adaptive capability.

The central evidence-based message is that comparable levels of investment pressure may coexist with different cash flow stability and financing exposure configurations. The interpretive contribution is the proposition that technology-intensive transformation should be evaluated against firms' financial ability to absorb such demands while recognizing that the processes creating those differences are beyond this design. These distinctions favor profile-specific monitoring over a one-size-fits-all approach to ranking firms.

Managerial Implications

These profiles support differentiated financial monitoring, not claims about firm-specific causal mechanisms. Management should jointly monitor operating cash stability, the frequency of residual cash deficits, investment commitments, and leverage; a temporary negative FCF during positive-OCF expansion calls for different decisions than recurring negative OCF under high leverage. This combined assessment is consistent with the emphasis on viewing material exposures together in enterprise risk management (Nocco & Stulz, 2022). The following implications are managerial interpretations conditional on the observed profiles; they were not directly tested as interventions:

For relatively resilient cash generators, financial flexibility should be preserved during expansion by applying disciplined hurdle rates, maintaining liquidity buffers, and re-evaluating projects against cash generation and productive returns. Financial flexibility can retain strategic value when external finance is constrained (Gamba & Triantis, 2008; Bates et al. 2009).

For investment-sensitive but operating-cash-resilient firms, sequence capital releases against commissioning, utilization, production stability, and expected operating cash contribution. When investment spending and the arrival of project benefits are misaligned, temporary FCF pressure may rise despite positive OCF; therefore, investment and financing decisions should be coordinated (Froot et al. 1993; Mauboussin & Callahan, 2014).

Multidimensional elevated-risk profiles warrant scenario analysis, liquidity stress tests, project prioritization, and continuous leverage monitoring before discretionary expansion. Preserving cash can protect viable investments when financing is constrained and operating cash is volatile (Almeida et al. 2004; Denis & Sibilkov, 2010).

Persistent cash flow and financing vulnerability first require diagnosing operating cash weakness, reassessing refinancing and maturity exposure, strengthening working capital, and separating sustaining from discretionary CAPEX. Risk governance should protect an enterprise's capacity to execute viable strategies rather than merely minimizing reported volatility (Nocco & Stulz, 2022).

Technology-intensive downstreaming also requires attention to whether financial resources, facilities, operational routines, and organizational capabilities mature at a compatible speed. Dynamic capability theory provides an interpretive rationale for tracking project readiness, utilization, and technological reliability alongside financial metrics; however, these capabilities were not measured or tested in this study (Eisenhardt & Martin, 2000; Teece, 2007).

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Across nine Indonesian listed mining firms observed during 2018–2025, five accounting-based indicators identify pronounced differences in operating cash flow volatility, downside cash outcomes, capital commitment, and financing exposure. The four descriptive patterns are relatively resilient cash generators, investment-sensitive but operating-cash-resilient firms, multidimensional elevated-risk firms, and persistent cash flow and financing vulnerability.

Most importantly, negative FCF during positive OCF and comparatively high investment commitment is not equivalent to recurring negative OCF accompanied by high leverage.

These findings converge with the broader literature's recognition that cash flow instability and financing conditions matter for corporate vulnerability (Keefe & Nguyen, 2023; Li et al. 2023) and that Indonesia's downstreaming outcomes vary across firms and industries (Schröder & Iwasaki, 2024; Warburton, 2024; Firmanto et al. 2025). The contribution differs in unit and method: rather than evaluating industrial policy effects or estimating an average financial-risk relation, it uses a transparent, non-weight combination of financial statement indicators to distinguish the sources of firm-level exposure. The theoretical implication is a sharper conceptual separation between investment-driven residual cash absorption, and persistent operating cash weakness. It does not validate dynamic capabilities, absorptive capacity, or technological intensity as causal drivers.

The practical implications follow from the profile differences. Managers and investors should integrate OCF resilience, the timing and persistence of FCF deficits, capital commitments, and leverage rather than treating a negative FCF year or high CAPEX intensity as sufficient evidence of distress. The descriptive typology can support differentiated monitoring and inquiry, but its categories are not credit ratings or predictions of default.

Limitations. The study comprises only nine purposively selected companies and 72 firm-year observations; therefore, profiles and sample medians are not representative industry thresholds. Its design is descriptive and exploratory: no causal or inferential testing distinguishes the effects of policy, commodity cycles, company restructuring, or project maturity. The classification rules were specified ex-post and could change under different firms or benchmark cut-offs. Technology capability and downstream project performance were not directly measured.

Recommendations

Managers should tailor financial monitoring of the sources of risk observed. Firms with positive operating cash generation but investment-related FCF pressure should prioritize investment sequencing, liquidity reserves, and their project milestones. Firms with high volatility, operating cash deficits, and/or leverage should emphasize operating cash stabilization, refinancing exposure, and selective capital allocation. These proposals have implications for profile descriptions and require firm-level verification before implementation.
Future research should test the stability of the ex-post typology using larger samples and alternative benchmarks, add annual source-linked data for independent replication, and examine commodity prices, project timing, restructuring, technological readiness, plant utilization, and direct measures of organizational capabilities. Longitudinal or causal research designs are required to evaluate whether downstreaming strategies contribute to subsequent financial resilience.

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