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Determinants of Cash Holding in Capital Intensive Electricity Firms in Asia

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Kata Kunci

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ABSTRAK

Capital-intensive electricity firms in Asia face significant liquidity pressures because they must finance long-term infrastructure while maintaining reliable daily operations. Their cash policies also reflect regulated revenues, debt obligations, working capital requirements, and country-level political conditions. Previous studies have mainly examined broad groups of non-financial firms and provide limited evidence on electricity utilities. This study investigates the determinants of cash holdings in 31 capital-intensive electric utility companies across Asia from 2016 to 2024. It analyzes the effects of operating cash flow volatility, capital expenditure intensity, leverage, net working capital, and sovereign risk, with revenue growth, profitability, and firm size as control variables. Sovereign risk is measured using the inverse of the Political Stability and Absence of Violence/Terrorism indicator from the Worldwide Governance Indicators. The initial dataset includes 279 firm-year observations, while the dynamic model uses 248 observations after incorporating lagged variables. Cash holding is calculated as the ratio of cash and cash equivalents to total assets. The Two-Step System Generalized Method of Moments (System GMM) approach is employed to address dynamic persistence, unobserved firm heterogeneity, and potential endogeneity, with Difference GMM and a winsorized System GMM model used as robustness tests. The findings robustly show that lagged cash holding has a positive and significant effect, confirming strong liquidity persistence, while net working capital shows a significant negative effect, supporting the liquidity substitution argument. In contrast, cash flow volatility, capital expenditure intensity, leverage, sovereign risk, and the control variables do not show significant effects in the main model. By presenting sector-specific evidence, this study demonstrates that historical liquidity and working-capital structure explain cash holdings more consistently than operational uncertainty, investment intensity, leverage, and country risk within this specific sector.

INTRODUCTION

The electricity sector is one of the most capital-intensive industries in the global economy, requiring continuous investment in generation facilities, transmission networks, distribution infrastructure, energy storage systems, and grid modernization. This substantial investment requirement is underscored by projections from the International Energy Agency (IEA), which estimate global energy investment to reach USD 3.3 trillion in 2025, with a significant portion USD 2.2 trillion allocated to clean energy technologies. Figure 1 illustrates the remarkable growth of global clean energy investment compared with fossil fuel investment between 2015 and 2025, highlighting the sector's ongoing transformation and increasing financial demands

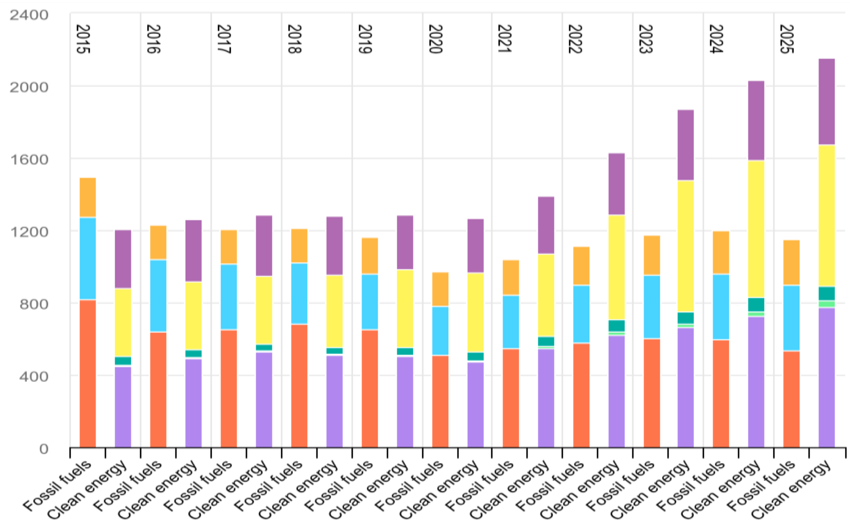

Figure 1. Global Investment in Clean Energy and Fossil Fuels, 2015-2025

Source: International Energy Agency (2025).

Given the immense capital requirements associated with long-term assets and infrastructure, enterprises in the energy sector must prioritize maintaining appropriate cash levels. Effective cash management is crucial for ensuring business continuity, financing capital expenditures, and avoiding financial constraints amid uncertain economic conditions (Nguyen et al., 2020). This challenge is particularly acute for electricity utilities, which operate under regulated tariff structures, experience long investment recovery periods, and incur significant fixed operating costs. These unique characteristics place considerable pressure on liquidity management and overall financial sustainability. Corporate finance theory offers several perspectives on this issue, arguing that firms hold cash for transaction purposes, as a precaution against uncertainty, and to exploit investment opportunities (Keynes, 1936; Opler et al., 1999). However, the optimal level of cash holdings depends on the specific characteristics and business environment of each company.

In capital-intensive sectors such as electricity utilities, the trade-off between maintaining liquidity reserves and investing in long-term capital expenditures is particularly critical. The need for substantial capital expenditures can constrain internal cash generation, while insufficient liquidity may result in operational disruptions and financing difficulties (Bates et al., 2009; Riddick & Whited, 2009). Despite its importance, most empirical research on corporate cash holdings has focused on manufacturing firms or diversified cross-industry samples, predominantly from developed economies (Ferreira & Vilela, 2004). Consequently, empirical studies specifically examining energy utilities in Asia remain limited. This represents a significant research gap, given the diversity of regulatory frameworks, ownership structures, and financial market conditions across the Asian region. This study directly addresses this gap by investigating cash-holding behavior determinants among capital-intensive electricity enterprises in Asia.

Asian power utilities face a distinctive financial dilemma, requiring them to balance the need for sufficient financial reserves with the risks associated with holding excessive cash. On the one hand, they require reserves to mitigate operational risks, such as fuel price volatility, foreign exchange exposure, delays in regulatory tariff adjustments, and collection inefficiencies (Han & Qiu, 2007; Nguyen et al., 2020). On the other hand, accumulating excessive financial reserves may create opportunity costs and reduce investment efficiency, particularly in a sector requiring continuous infrastructure development (Bates et al., 2009). The situation is further complicated by the fact that several Asian electricity utilities operate under public service obligations and are partially owned by governments. Government intervention and regulatory restrictions can significantly influence financial behavior, including liquidity policies and investment decisions (Boubakri et al., 2013; Borisova & Megginson, 2011). The absence of empirical, sector-specific benchmarks for optimal cash-holding levels limits managerial decision-making, potentially causing utilities to rely on internal policy objectives rather than data-driven financial optimization, thereby increasing liquidity risks or constraining strategic investment opportunities.

Based on this background, this study addresses the following research questions: (1) What are the key financial determinants of cash-holding levels in capital-intensive electricity firms in Asia? (2) How does operating cash flow volatility influence precautionary cash-holding behavior? (3) What is the relationship between capital expenditure intensity and cash-holding policies? (4) How do leverage and net working capital affect cash-holding decisions? (5) How does sovereign risk influence cash-holding decisions? Correspondingly, this study aims to empirically identify the key determinants of cash holdings and examine the specific effects of operating cash flow volatility, capital expenditure intensity, leverage, net working capital, and sovereign risk on cash holdings in these firms.

This research focuses on electricity and utility corporations across Southeast Asia, East Asia, South Asia, Central Asia, and West Asia over a nine-year period (2016–2024), covering firms engaged in power generation, transmission, and distribution. A quantitative panel data methodology is employed. Several limitations should be acknowledged: the study relies on publicly disclosed financial statements, which may not fully capture internal treasury policies, committed credit facilities, or off-balance-sheet liquidity instruments (Sufi, 2009). Furthermore, variations in regulatory frameworks, accounting standards, and tariff systems among countries may create heterogeneity that cannot be fully controlled. The research centers on firm-specific financial variables without explicitly modeling all macroeconomic or institutional factors. Notwithstanding these constraints, the study is expected to provide meaningful empirical insights into liquidity management practices among Asian energy utilities.

Cash holding is one of the most essential financial policy decisions in corporate finance because it directly influences liquidity management, investment capacity, and financial flexibility. This study draws on five complementary theories to frame its analysis. The Trade-Off Theory conceptualizes corporate cash holdings as a balance between the benefits of liquidity (lower transaction costs, reduced probability of financial distress, and greater operational flexibility) and the costs of holding excess cash (foregone investment returns and potential agency problems) (Opler et al., 1999; Bates et al., 2009). This trade-off is especially important for capital-intensive electricity companies facing substantial fixed costs and regulatory constraints. The Precautionary Motive Theory suggests that firms accumulate cash as a buffer against uncertainty in future cash flows to avoid costly external financing and operational disruptions (Keynes, 1936; Han & Qiu, 2007). This motive is particularly relevant for Asian power companies due to volatile fuel prices, foreign exchange risks, regulatory delays, and demand fluctuations (Riddick & Whited, 2009; Chen et al., 2018). The Pecking Order Theory explains that information asymmetry between managers and external investors makes external financing more costly, leading firms to prioritize retained earnings and cash holdings over debt financing, with equity issuance as a last resort (Myers & Majluf, 1984). This hierarchy is highly relevant for utilities that continuously invest in generation, transmission, distribution, and renewable energy assets. The Agency Theory perspective suggests that managers may accumulate cash beyond operational requirements to maintain managerial flexibility in the absence of effective monitoring mechanisms (Jensen, 1986; Dittmar et al., 2003). Notably, state ownership may further influence managerial incentives and monitoring mechanisms, with some studies indicating that government participation can increase cash holdings while reducing inefficient overinvestment (Yang et al., 2023). Finally, the Dynamic Adjustment Theory of Cash Holding argues that firms do not immediately achieve their optimal cash levels due to transaction costs, financing frictions, and unexpected changes in operating conditions. Therefore, current cash holdings partially reflect previous-period cash balances and adjust gradually toward target levels (Opler et al., 1999; Flannery & Rangan, 2006; Ozkan & Ozkan, 2004). Together, these theories justify the inclusion of a lagged dependent variable and the use of a dynamic panel estimator in this study.

Prior cash-holding research, generally organized around the aforementioned theories, has primarily examined general non-financial firms in developed markets or single-country samples. Table 1 summarizes representative streams of this literature, highlighting the limited evidence regarding capital-intensive electricity firms across Asia. For instance, while Opler et al. (1999), Ferreira and Vilela (2004), and Drobetz and Gruninger (2007) provided foundational evidence on the effects of leverage, growth opportunities, and cash flow on cash holdings, their studies focused on broad firm populations. Similarly, Ozkan and Ozkan (2004) confirmed dynamic adjustment processes among UK companies, but their analysis remained focused on general firms. Studies on state ownership (Boubakri et al., 2013; Yang et al., 2023; Chen et al., 2018) and emerging markets (Bagh et al., 2021; Diaw, 2021; Akhtar, 2023) have explored important determinants, but they often do not specifically examine the capital-intensive utility sector. While Nguyen and Nguyen (2020) provided sector-specific evidence for Vietnamese energy firms, their research focused on earnings management rather than broader financial determinants. Methodological studies (Blundell et al., 2000; Bond, 2002) have established the effectiveness of System GMM for dynamic panel data analysis, which is the technique adopted in this study.

Table 1. Summary of Selected Previous Studies and Research Gap

Author(s) / Year	Focus	Key Finding
Opler et al. (1999); Ferreira & Vilela (2004); Drobetz & Gruninger (2007)	General non-financial firms	Leverage, growth opportunities, cash flow, firm size, and liquid assets influence corporate cash balances.
Ozkan & Ozkan (2004)	UK companies	Cash holdings follow a dynamic adjustment process; current cash position is partly determined by the prior period's cash level.
Han & Qiu (2007); Riddick & Whited (2009)	Financially constrained firms	Cash flow volatility raises precautionary cash savings and firms use cash as a hedge for investment/financing flexibility.
Das et al. (2024)	Economic policy uncertainty	Policy uncertainty and inflation risk shape corporate cash reserves.
Dittmar et al. (2003); Alves et al. (2022)	Cross-country governance	Investor protection, governance quality, financial-system development, and rule of law explain cross-country cash policy differences.
Boubakri et al. (2013); Yang et al. (2023); Chen et al. (2018)	Political connections / state ownership	Political connections and state ownership influence cash-holding behavior, financing access, and governance.
Bagh et al. (2021); Diaw (2021); Akhtar (2023)	Emerging/frontier Asian markets	Firm-level determinants matter, cash holding follows a dynamic process, and holding motives differ between developed and emerging markets.
Nguyen & Nguyen (2020)	Vietnamese energy firms	Sector-specific evidence, but focused on earnings management rather than broader financial determinants.
Blundell et al. (2000); Bond (2002)	Dynamic panel methodology	Conventional static estimators may be biased when the dependent variable is persistent and potentially endogenous; System GMM combines level and differenced equations using internal instruments.

Source: synthesized from the literature reviewed in this study.

Despite these developments, previous studies rarely focus on capital-intensive electricity firms across Asia as a distinct industry group. Furthermore, firm-level financial determinants and country-level institutional risk are often examined separately. Limited research combines operating cash flow volatility, capital expenditure intensity, leverage, net working capital, and sovereign risk within one dynamic cash-holding model specifically for electricity utilities. This study addresses these gaps by providing industry-specific evidence from 31 capital-intensive electricity firms across Asia. It integrates firm-level determinants with sovereign risk, measured through the reversed WGI Political Stability indicator, and applies a rigorous Two-Step System GMM methodology with a restricted lag structure and collapsed instruments. Robustness is further examined using Difference GMM, a model excluding sovereign risk, and a winsorized specification.

The conceptual framework for this study posits that cash reserves of capital-intensive power companies are shaped by four primary firm-level financial factors: cash flow volatility, capital expenditure intensity, leverage, and net working capital, together with a country-level sovereign risk factor. Revenue growth, profitability, and firm size act as control variables, capturing differences in financing access, internal cash generation, and business expansion.

Cash flow volatility reflects operational risk and uncertainty. Under the precautionary motive, firms facing higher volatility are expected to hold larger cash reserves as a buffer against unforeseen cash deficits (Han & Qiu, 2007; Riddick & Whited, 2009). This mechanism is particularly relevant to electricity firms that face uncertainty from fuel prices, tariff adjustments, subsidy settlement, foreign-exchange movements, and demand changes. Therefore, the first hypothesis is:

- H1: Operating cash flow volatility has a positive and significant effect on cash holding in capital-intensive electricity firms in Asia.

Capital expenditure reflects the scale of long-term investment commitments. While some studies suggest that high capital expenditure reduces cash holdings through resource reallocation, others argue that firms build cash reserves to secure future investment financing (Bates et al., 2009; Opler et al., 1999; Alnori et al., 2022). Given the continuous investment requirements of electricity infrastructure and the Pecking Order Theory's prediction of a preference for internal funds, firms with higher CAPEX intensity are expected to maintain larger cash reserves. This leads to the second hypothesis:

- H2: Capital expenditure intensity has a positive and significant effect on cash holding in capital-intensive electricity firms in Asia.

Leverage indicates a firm's dependence on debt financing. Trade-off theory posits that debt can substitute for cash because firms with better access to loan markets may need smaller liquidity buffers (Ozkan & Ozkan, 2004). Empirical work often finds an inverse relationship between leverage and cash reserves (Opler et al., 1999; Ferreira & Vilela, 2004). Treating debt as an alternative financing source, this study expects a negative relationship:

- H3: Leverage has a negative and significant effect on cash holding in capital-intensive electricity firms in Asia.

Net working capital represents an alternative liquidity source: firms with elevated non-cash working capital can use receivables and inventories as near-cash substitutes, reducing the need for large cash reserves (Baum et al., 2017; Opler et al., 1999). In electricity utilities, billing cycles, fuel-procurement agreements, and regulatory receivables substantially affect working-capital dynamics, making this substitution effect particularly pertinent. The fourth hypothesis is therefore:

- H4: Net working capital has a negative and significant effect on cash holding in capital-intensive electricity firms in Asia.

Country-level institutional conditions can influence corporate liquidity decisions. Political instability may raise financing costs, weaken investor confidence, disrupt operations, and create regulatory uncertainty, encouraging firms to preserve additional cash as a precautionary buffer. This study measures sovereign risk by inverting the WGI Political Stability and Absence of Violence/Terrorism Estimate, so that a higher value represents greater political and institutional risk. The final hypothesis is:

- H5: Sovereign risk has a positive and significant effect on cash holding in capital-intensive electricity firms in Asia.

Overall, the conceptual framework combines the precautionary motive, Trade-Off Theory, and Pecking Order Theory to explain cash-holding decisions in capital-intensive electric utilities. Sovereign risk is introduced as a country-level factor that may further shape corporate liquidity behavior in this sector, which is characterized by high capital intensity, regulated operations, long investment cycles, and exposure to political conditions.

METHOD

This study employed a quantitative explanatory research design using a panel-data approach that combined cross-sectional firm-level data with time-series observations to examine variations across firms and dynamic changes over time. Panel data enabled the study to control for unobserved firm-specific heterogeneity and reduce potential omitted-variable bias (Baltagi, 2005). A dynamic panel specification was incorporated by including lagged cash holdings as an explanatory variable to capture the persistence of corporate liquidity strategies and gradual adjustment toward target cash levels (Ozkan & Ozkan, 2004). This dynamic specification also helped address potential endogeneity arising from reverse causality between cash holdings and their determinants. The unit of analysis was the firm-year observation.

The sample consisted of 31 capital-intensive electric utilities operating across East Asia, Southeast Asia, South Asia, Central Asia, and West Asia during 2016–2024. The sample included listed and unlisted companies, as well as state-owned and government-controlled electric utilities, to provide broader sectoral representation. A purposive sampling method was applied based on the following criteria: (a) firms primarily engaged in electricity generation, transmission, distribution, or integrated utility activities; (b) firms operating in Asian countries with sufficient annual financial data during 2016–2024; (c) firms providing the financial information required to calculate cash holdings and related determinants; (d) firms operating in countries with available Worldwide Governance Indicators data for constructing the sovereign risk variable; and (e) firms without substantial data gaps or inconsistent disclosures. The initial panel dataset contained 279 firm-year observations from 31 firms over nine years. The dynamic System GMM estimation used 248 observations due to the inclusion of lagged cash holdings in the model, while all 31 firms remained included in the estimation. Secondary financial data were collected from annual reports and audited financial statements published on company investor-relations websites, as well as financial databases such as Yahoo Finance, Investing.com, MarketScreener, and the World Bank. The observation period ended in 2024 because the Worldwide Governance Indicators data required for constructing the sovereign risk variable were unavailable for 2025.

Cash holdings were used as the dependent variable. The main explanatory variables consisted of operating cash flow volatility, capital expenditure intensity, leverage, net working capital, and sovereign risk. Revenue growth, profitability, and firm size were included as control variables. Table 2 presents the symbols, formulas, and operational measurements of all variables used in the study.

Table 2. Definition and Measurement of Variables

Variable	Symbol	Formula	Description
Cash Holding (dependent)	CH	Cash & Cash Equivalent / Total Assets	Proportion of cash and cash equivalents relative to total assets (Opler et al., 1999).
Operating Cash Flow Volatility	CFV	SD(OCF/TA), rolling 3 years	Variability of operating cash flow over time; represents uncertainty in internal cash generation (Han & Qiu, 2007).
Capital Expenditure Intensity	CAPEX	Capital Expenditure / Total Assets	Scale of long-term investment relative to firm size (Opler et al., 1999).
Leverage Level	LEV	Total Debt / Total Assets	Proportion of assets financed by debt (Ozkan & Ozkan, 2004).
Net Working Capital	NWC	(CA - Cash - CL) / Total Assets	Non-cash working capital as an alternative liquidity source (Opler et al., 1999).
Growth Opportunity	GROWTH	$(\text{Revenue}_t - \text{Revenue}_{t-1}) / \text{Revenue}_{t-1}$	Annual revenue growth; captures future operating/investment needs (Ozkan & Ozkan, 2004).
Return on Assets	ROA	Net Income / Total Assets	Profitability from the firm's asset base (Opler et al., 1999; Akhtar, 2023).
Size of Company	SIZE	ln(Total Assets)	Firm scale; captures financing access and flexibility (Opler et al., 1999).
Sovereign Risk	SR	SR = -PV.EST	Reversed WGI Political Stability and Absence of Violence/Terrorism Estimate, so higher SR means higher risk (World Bank, 2025).

Source: processed from the variable definitions used in this study.

The analysis began with descriptive statistics to summarize the distribution, central tendency, and variation of the variables. This was followed by Pearson correlation analysis and Variance Inflation Factor (VIF) diagnostics to assess potential multicollinearity. Panel regression techniques, including Pooled OLS, Fixed Effects, and Random Effects models, were then estimated, with the Hausman test applied to determine the preferred conventional specification (Hausman, 1978). However, because corporate cash holdings are inherently dynamic and several explanatory variables, such as leverage, capital expenditure intensity, and net working capital, may be jointly determined with liquidity decisions, conventional estimators may produce biased and inconsistent estimates (Arellano & Bond, 1991; Blundell & Bond, 1998; Bond, 2002). Therefore, the study employed the Two-Step System Generalized Method of Moments (System GMM) estimator developed by Blundell and Bond (1998) and Arellano and Bover (1995) as the primary estimation method. This estimator combined equations in first differences and levels by using internal instruments derived from appropriate lags of endogenous and predetermined variables. Restricted lag structures and collapsed instruments were applied to mitigate instrument proliferation, which could weaken specification tests (Roodman, 2009). Model validity was evaluated using the Arellano-Bond test for first- and second-order serial correlation, while instrument validity was assessed through the Hansen and Sargan tests. Robustness analyses were further conducted using Difference GMM, a model specification excluding sovereign risk, and a winsorized System GMM estimation.

$$CHit = \alpha i + \beta 1\ CHi,t\text{-}1 + \beta 2\ CFVit + \beta 3\ CAPEXit + \beta 4\ LEVit + \beta 5\ NWCit + \beta 6\ GROWTHit + \beta 7\ ROAit + \beta 8\ SRit + \beta 9\ SIZEit + \gamma t + \varepsilon it$$

RESULTS AND DISCUSSION

Descriptive Analysis

Table 3 presents the descriptive statistics of the 279 firm-year observations from 31 electric utilities across Asia during 2016-2024. The average cash-holdings ratio is 0.0469 (4.69% of total assets), ranging from 0.03% to 40.38%. This considerable range reflects significant differences in liquidity management across firms, likely stemming from diverse regulatory environments, ownership structures, funding policies, and investment strategies. Operating cash flow volatility averages 0.0880 with a standard deviation of 0.5538 and a maximum of 5.3901, indicating that some firms experienced significant fluctuations in operating cash flow. Capital expenditure intensity averages 0.0719 (with a maximum of 0.8459), which is consistent with the electricity industry's need for sustained investment in generation, transmission, and distribution infrastructure. The average leverage ratio is 0.6140, confirming that electric utilities rely heavily on debt financing. The average net working capital is -0.0643, indicating that short-term liabilities exceed non-cash current assets for most sampled firms. This is a pattern common in regulated utilities with stable operating cash flow, as they can operate with negative working capital. Among the control variables, average revenue growth is 9.13%, average ROA is 2.65%, and average firm size (ln total assets) is 27.47, confirming a sample of medium to very large utilities. Sovereign risk averages 0.1968, ranging from -1.3859 to 1.4629, reflecting considerable differences in institutional and political conditions among the sampled countries.

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CH	279	0.0469	0.0560	0.0003	0.4038
CFV	279	0.0880	0.5538	0.0011	5.3901
CAPEX	279	0.0719	0.0720	0.0000	0.8459
LEV	279	0.6140	0.1741	0.2489	1.2328
NWC	279	-0.0643	0.1082	-0.3514	0.2493
GROWTH	279	0.0913	0.2121	-0.6446	2.1839
ROA	279	0.0265	0.0371	-0.2201	0.1381
SR	279	0.1968	0.6645	-1.3860	1.4630
SIZE	279	27.4679	2.6439	23.4463	35.1111

Source: author's estimation from the study's panel dataset.

Correlation and Multicollinearity Analysis

Table 4 presents the Pearson correlation matrix. Cash holdings (CH) show a statistically significant negative correlation with capital expenditure intensity ($r = -0.1421$, $p < 0.05$), leverage ($r = -0.2191$, $p < 0.01$), and firm size ($r = -0.2868$, $p < 0.01$). This suggests that firms with higher investment intensity, greater debt financing, and a larger asset base tend to hold less cash, which is consistent with the investment-demand perspective and Trade-Off Theory (Opler et al., 1999; Bates et al., 2009). Cash holdings also correlate positively with ROA ($r = 0.1868$, $p < 0.01$) and sovereign risk ($r = 0.1287$, $p < 0.05$), which is consistent with the Pecking Order Theory (where more profitable firms have more cash) and the precautionary motive (where firms in riskier countries hold more cash), respectively (Myers & Majluf, 1984; Bates et al., 2009). Cash flow volatility, net working capital, and growth show no significant bivariate correlation with cash holdings. This is not unexpected, as such simple pairwise relationships often only become apparent once firm-specific heterogeneity, dynamic persistence, and endogeneity are controlled through panel estimation (Opler et al., 1999; Nguyen et al., 2020). Among the explanatory variables, the strongest correlations are between leverage and ROA ($r = -0.5522$) and between leverage and net working capital ($r = -0.4847$). However, none exceeds the commonly used threshold of 0.80 (Gujarati & Porter, 2009), indicating that severe multicollinearity is not a concern.

Table 4. Pearson Correlation Matrix

	CH	**CFV**	**CAPEX**	**LEV**	**NWC**	**GROWTH**	**ROA**	**SR**	**SIZE**
CH	1.000								
CFV	-0.015	1.000							
CAPEX	-0.142*	0.431*	1.000						
LEV	-0.219*	0.002	0.155*	1.000					
NWC	0.077	0.122*	0.078	-0.485*	1.000				
GROWTH	0.018	0.019	0.166*	0.100	-0.076	1.000			
ROA	0.187*	0.052	-0.041	-0.552*	0.217*	-0.071	1.000		
SR	0.129*	0.034	0.103	0.150*	0.293*	0.083	-0.099	1.000	
SIZE	-0.287*	-0.025	-0.063	0.112	0.014	0.006	-0.327*	-0.043	1.000

Source: indicates significance at the 5% level. Source: author's estimation.*

Table 5 reports the Variance Inflation Factor (VIF) results, confirming that multicollinearity is not a serious concern. Leverage records the highest VIF (2.09), followed by net working capital (1.71) and ROA (1.67). All remaining variables, including the annual year dummies (1.79-1.90), fall well below the common thresholds of 5 and 10 (Hair et al., 2022), with a mean VIF of 1.64.

Table 5. Variance Inflation Factor (VIF) Results

Variable	**VIF**	**1/VIF**
LEV	2.09	0.478

NWC	1.71	0.584
ROA	1.67	0.599
SR	1.29	0.774
CAPEX	1.37	0.730
CFV	1.28	0.779
SIZE	1.16	0.864
GROWTH	1.14	0.880
Year dummies (2017-2024)	1.79 - 1.90	0.527 - 0.557
Mean VIF	1.64	-

Source: author's estimation.

Panel Regression Results

Table 6 reports the preliminary Pooled OLS, Fixed Effects, and Random Effects estimates. Lagged cash holding is positive and statistically significant across all three specifications, confirming the persistence of corporate cash-holding policy. Net working capital is negatively significant under Pooled OLS and Random Effects. ROA is positively significant under Fixed Effects, and growth is positively significant under Pooled OLS and Random Effects. Capital expenditure, leverage, sovereign risk, and firm size are generally insignificant in these conventional models. The Hausman specification test yields chi2(9) = 28.16 with Prob > chi2 = 0.0009, favoring the Fixed Effects model over Random Effects. However, because the model includes lagged cash holding and potentially endogenous regressors, the Fixed Effects estimator is retained only as a conventional benchmark. The Two-Step System GMM estimator is used as the main estimation technique to address these dynamic panel biases.

Table 6. Pooled OLS, Fixed Effects, and Random Effects Results

Variable	Pooled OLS	Fixed Effects	Random Effects
L.CH	0.8324 (0.000)	0.6259 (0.001)	0.8324 (0.000)
CFV	0.0001 (0.847)	-0.0034 (0.080)	0.0001 (0.961)
CAPEX	-0.0188 (0.143)	-0.0132 (0.419)	-0.0188 (0.454)
LEV	-0.0025 (0.642)	-0.0128 (0.763)	-0.0025 (0.834)
NWC	-0.0304 (0.040)	-0.0993 (0.101)	-0.0304 (0.090)
GROWTH	0.0191 (0.054)	0.0138 (0.121)	0.0191 (0.009)
ROA	0.0680 (0.071)	0.1455 (0.039)	0.0680 (0.159)
SR	-0.0013 (0.387)	0.0110 (0.248)	-0.0013 (0.603)
SIZE	-0.0004 (0.359)	0.0192 (0.298)	-0.0004 (0.498)
Year fixed effects	Yes	Yes	Yes
Number of companies	31	31	31

Note: p-values in parentheses. Hausman test: chi2(9) = 28.16, Prob > chi2 = 0.0009. Source: author's estimation.

Dynamic Panel (Two-Step System GMM) Results

Table 7 presents the main Two-Step System GMM results using 248 firm-year observations from 31 firms, with 18 instruments, which is below the number of cross-sectional groups and limits the risk of instrument proliferation. The model as a whole is highly significant, $F(16,30) = 4993.38$ ($p < 0.001$). Lagged cash holding is positive and highly significant ($\beta = 0.9600$, $p < 0.001$), confirming strong dynamic persistence. Net working capital is negative and significant ($\beta = -0.0404$, $p = 0.013$), providing support for the liquidity substitution hypothesis. In contrast, operating cash flow volatility ($\beta = -0.0009$, $p = 0.358$), capital expenditure intensity ($\beta = 0.0007$, $p = 0.971$), leverage ($\beta = 0.0015$, $p = 0.862$), and sovereign risk ($\beta = -0.0006$, $p = 0.753$) are all statistically insignificant. The control variables growth ($\beta = 0.0172$, $p = 0.079$), ROA ($\beta = 0.0756$, $p = 0.057$), and firm size ($\beta = 0.0004$, $p = 0.536$) are also insignificant, although growth and ROA are marginally significant at the 10 percent level. Year dummies for 2020, 2021, and 2024 are negative and significant at the 5 percent level, indicating lower cash-holding ratios in those years relative to the reference year. However, these should not be interpreted purely as a COVID-19 effect, as they may also capture tariff adjustments, financing conditions, and other macroeconomic developments (Javadi et al., 2021).

Table 7. Two-Step System GMM Results

Variable	Coefficient	Std. Err.	t	P>|t|
L.CH	0.9600	0.0824	11.65	0.000
CFV	-0.0009	0.0010	-0.93	0.358
CAPEX	0.0007	0.0183	0.04	0.971
LEV	0.0015	0.0087	0.17	0.862
NWC	-0.0404	0.0153	-2.64	0.013
GROWTH	0.0172	0.0095	1.82	0.079
ROA	0.0756	0.0382	1.98	0.057
SR	-0.0006	0.0020	-0.32	0.753
SIZE	0.0004	0.0007	0.63	0.536
Constant	-0.0077	0.0233	-0.33	0.744
Observations / Groups	248 / 31			
Number of instruments	18			
F(16,30); Prob > F	4993.38; 0.000			
AR(1) p-value	0.040			
AR(2) p-value	0.104			
Hansen test (p-value)	0.885			
Sargan test (p-value)	0.918			

Note: dependent variable is CH; year dummies (2017-2024) included but omitted from the table for brevity. Source: author's estimation.

The diagnostic tests support the validity of the GMM specification. The AR(1) test ($p = 0.040$) confirms first-order serial correlation, which is expected after first differencing. Crucially, the AR(2) test ($p = 0.104$) shows no evidence of second-order serial correlation, supporting the validity of the lagged instruments (Arellano & Bond, 1991). The

Hansen test (p = 0.885) and Sargan test (p = 0.918) both fail to reject the null hypothesis that the instruments are valid. Because the instrument count (18) remains below the number of firms (31) and the model applies the collapse option restricted to the second lag of cash holding, the risk that a high Hansen p-value merely reflects instrument proliferation is limited (Roodman, 2009). Overall, the diagnostic results support the System GMM specification as a reliable basis for interpreting the estimated determinants of cash holding.

Discussion of Findings

The System GMM results provide support for only one of the five main hypotheses. Net working capital (NWC) reaches statistical significance at the 5 percent level, supporting H4. In contrast, cash flow volatility, capital expenditure intensity, leverage, and sovereign risk do not show significant effects, meaning H1, H2, H3, and H5 are not supported. The high level of state ownership in the electricity sector may partly explain why these conventional cash-holding determinants show a weaker effect, as state ownership can alter liquidity behavior through governance and investment channels (Yang et al., 2023).

The lagged cash coefficient of 0.9600 confirms strong persistence in the cash-holding policies of Asian electric utilities: a one-unit increase in the previous year's cash ratio is associated with a 0.9600-unit increase in the current year's cash ratio, holding other variables constant. The implied speed of adjustment, calculated as 1 - 0.9600 = 0.0400, indicates that sampled firms close only about 4 percent of the gap between actual and target cash holdings each year. This is a relatively slow pace, consistent with large infrastructure commitments, tightly regulated operations, and long planning cycles (Ozkan & Ozkan, 2004; Begenau & Palazzo, 2021).

The finding for operating cash flow volatility ($\beta = -0.0009$, $p = 0.358$) contradicts the hypothesized positive relationship, so H1 is not supported. The small negative and insignificant coefficient suggests that firms do not increase cash reserves in response to cash flow fluctuations. This may reflect the regulated revenue environment in which these utilities operate. With revenues often subject to regulatory approval and government support, the need to adjust cash reserves in response to short-term operating cash flow fluctuations is reduced. This differs from findings in studies of general firms (Opler et al., 1999) but is plausible for state-influenced utilities.

Capital expenditure intensity shows a positive but negligible and insignificant coefficient (0.0007, p = 0.971), so H2 is not supported. This implies that capital expenditure is not a significant driver of cash accumulation. A plausible explanation is that electricity firms finance infrastructure projects through long-term debt, project financing, or government support rather than through accumulated cash. Furthermore, the timing of investment may not align with the concurrent annual model used in this study, potentially masking the relationship (Diaw, 2021).

Leverage carries a positive but statistically insignificant coefficient (0.0015, p = 0.862), contradicting the expected negative sign, so H3 is not supported. This surprising result may be explained by the specific financial needs of highly leveraged utilities. Firms with high debt levels may hold cash to meet interest payments, debt covenants, and refinancing needs, offsetting the substitution effect predicted by Trade-Off Theory (Elyasiani et al., 2022; Ozkan & Ozkan, 2004). In essence, for these firms, debt and cash are not substitutes but complements, driven by the need to manage debt-related risks.

Net working capital is the only main explanatory variable with a significant negative coefficient (-0.0404, $p = 0.013$), supporting H4 and the liquidity-substitution argument. This finding is robust and indicates that electricity firms with larger receivables, inventories, and other current assets can rely less on cash to meet short-term needs (Opler et al., 1999; Diaw, 2021). This is a logical outcome: non-cash working capital components can be converted to cash relatively quickly, providing a buffer against liquidity shocks and reducing the need to hold idle cash. This negative and significant relationship remains stable across all robustness specifications, confirming its importance as a key determinant for this sector.

Sovereign risk shows a small negative and insignificant coefficient (-0.0006, $p = 0.753$), contradicting the expected positive sign, so H5 is not supported. The lack of a significant effect may be attributed to the unique ownership structure of the sampled firms. Most sampled firms are state-owned or state-controlled, which may provide them with implicit guarantees and access to capital injections, government support, and policy-based financing. This state backing could reduce the need to hoard cash in response to country-level political risk. Additionally, the WGI-based proxy may capture broader institutional conditions rather than the specific firm-level financing constraints that would directly influence cash-holding decisions (World Bank, 2025).

Among the control variables, revenue growth (0.0172, $p = 0.079$) and profitability (0.0756, $p = 0.057$) show positive but only marginally significant coefficients. The positive signs are directionally consistent with Pecking Order Theory, as more profitable and growing firms generate more internal cash. Firm size (0.0004, $p = 0.536$) is positive and insignificant, suggesting that scale does not independently explain cash holding once other financial and country-level variables are controlled.

Robustness Tests

Table 8 compares the baseline System GMM model with three robustness specifications: Difference GMM (which removes the level equation), a System GMM model excluding sovereign risk, and a winsorized System GMM model that limits the influence of extreme observations. Across all specifications, lagged cash holding remains positive and highly significant, and net working capital remains negative and significant. This consistency confirms that dynamic persistence and the liquidity-substitution effect are the most robust findings of this study. Leverage, growth, profitability, sovereign risk, and firm size retain consistent coefficient signs but remain statistically insignificant across specifications. Cash flow volatility and capital expenditure intensity change sign across specifications and remain insignificant throughout, indicating that their estimated effects are not robust. All specifications pass the AR(2), Hansen, and Sargan diagnostic tests, with instrument counts remaining below the number of firms in every case. The robustness checks reinforce the conclusion that the primary drivers of cash holding in this sector are historical liquidity levels and the net working capital position.

Table 8. Robustness Tests: Comparison Across Model Specifications

Variable	System GMM (baseline)	Difference GMM	System GMM (no SR)	Winsorized System GMM
L.CH	0.9600 (0.000)	0.8426 (0.000)	0.9537 (0.000)	1.0853 (0.000)
CFV	-0.0009 (0.358)	0.0057 (0.059)	0.0008 (0.350)	0.0005 (0.648)
CAPEX	0.0007 (0.971)	-0.0070 (0.579)	-0.0073 (0.618)	0.0140 (0.646)
LEV	0.0015 (0.862)	0.0138 (0.798)	0.0027 (0.816)	0.0053 (0.730)
NWC	-0.0404 (0.013)	-0.1807 (0.032)	-0.0566 (0.003)	-0.0674 (0.011)
GROWTH	0.0172 (0.079)	0.0140 (0.179)	0.0169 (0.127)	0.0267 (0.200)
ROA	0.0756 (0.057)	0.1144 (0.145)	0.0779 (0.139)	0.0843 (0.237)
SR	-0.0006 (0.753)	-0.0068 (0.604)	excluded	-0.0028 (0.467)
SIZE	0.0004 (0.536)	0.0527 (0.285)	0.0005 (0.491)	0.0013 (0.231)
Observations	248	217	248	248
Number of firms	31	31	31	31
Number of instruments	18	16	17	18
AR(1) p-value	0.040	0.022	0.039	0.035
AR(2) p-value	0.104	0.107	0.104	0.137
Hansen p-value	0.885	0.869	0.988	0.928
Sargan p-value	0.918	0.895	0.992	0.942

Note: p-values in parentheses. Source: author's estimation.

CONCLUSION

This study examines the determinants of cash holdings in 31 capital-intensive electricity firms across Asia during 2016–2024 using the Two-Step System GMM approach on 248 firm-year observations. The analysis reveals that lagged cash holdings are the strongest determinant, with a positive and significant coefficient of 0.9600. This finding confirms strong dynamic persistence and an estimated annual adjustment speed of approximately 4%, which is consistent with the Dynamic Adjustment Theory of Cash Holding (Ozkan & Ozkan, 2004). Net working capital is the only main explanatory variable with a significant negative effect (-0.0404, p = 0.013), supporting H4 and the liquidity substitution argument. This result remains robust across Difference GMM, a model specification excluding sovereign risk, and a winsorized System GMM specification. In contrast, operating cash flow volatility, capital expenditure intensity, leverage, and sovereign risk do not show significant effects; therefore, H1, H2, H3, and H5 are not supported. This lack of significance may reflect the regulated revenue structures, government ownership, and policy-based financing access commonly observed among Asian electric utilities. Revenue growth and profitability are only marginally significant, while firm size is insignificant. These findings indicate that cash management in this sector is influenced more consistently by historical liquidity positions and working-capital structures than by annual fluctuations in volatility, investment intensity, debt levels, or country risk.

Based on these findings, several recommendations are proposed for electric utility managers. Firms, including PT PLN (Persero) as a sectoral reference, are encouraged to establish formal cash-target ranges rather than relying solely on historical cash balances to determine liquidity levels. Given the robust liquidity substitution effect, working-capital management should be more closely integrated with cash policy decisions. Although the effect of capital expenditure intensity is insignificant, liquidity planning should remain aligned with capital expenditure and financing schedules to ensure fund availability when required. Despite the insignificant effect of cash flow volatility, maintaining forward-looking liquidity stress testing remains advisable. Finally, sovereign risk should be considered a contextual factor rather than a direct determinant of cash targets. Future research is recommended to expand the sample size and observation period, distinguish utility business models and ownership structures, incorporate alternative sovereign risk measures, and examine the performance implications of different cash-holding policies.

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