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Drowning in Debt, Starving for Cash: The Liquidity Crisis and Circular Debt Catastrophe in Pakistan's Energy Sector

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ABSTRACT

The liquidity crisis in Pakistan's fuel and energy sector is one of the most pressing financial challenges, driven primarily by circular debt, weak institutional governance, and financial mismanagement. This study investigates the determinants of corporate liquidity in the sector, examining how firm-specific financial characteristics, debt structures, investment behavior, and risk exposure influence liquidity holdings. Using a panel dataset from 2006 to 2024, this research employs Pooled Least Squares (PLS), Fixed Effects Model (FEM), and Random Effects Model (REM) to analyze liquidity trends while applying the Hausman test to determine the best-fitting model. The results indicate that firm size, debt-to-asset ratios, and earnings risk significantly impact liquidity holdings, while circular debt emerges as the most critical constraint on financial stability. The study finds that firms with high leverage and short-term debt exposure hold liquidity buffers as a precautionary measure, aligning with the precautionary liquidity hypothesis. However, circular debt negatively impacts liquidity, restricting firms' ability to meet operational needs and invest in growth. The Hausman test favors the Random Effects Model (REM), suggesting that macroeconomic and policy-driven factors play a dominant role over firm-specific characteristics in determining liquidity management. The findings underscore the urgent need for regulatory and financial reforms, emphasizing the root causes of circular debt, such as delayed government payments, inefficient subsidy mechanisms, and weak institutional controls. Policy recommendations include establishing an independent energy regulatory authority, enforcing strict budgetary controls over energy subsidies, and introducing an automated payment clearing system to prevent liquidity constraints. The study contributes to academic discourse on liquidity management in emerging economies and provides actionable insights for policymakers and industry leaders to break free from the liquidity trap and restore financial stability in Pakistan's energy sector.

Overview

Corporate governance serves as the foundation for financial stability, sustainable economic growth, and investor confidence. The World Bank, IMF, and United Nations (UN) emphasize the role of strong corporate governance in ensuring transparency, accountability, and efficiency in financial markets. Developed economies like the United States, Germany, and Japan have adopted stringent corporate governance regulations, fostering economic resilience and sustained growth. The Sarbanes-Oxley Act (2002) in the U.S., for example, established strict regulatory controls that improved investor confidence and minimized financial fraud.

However, in developing countries, corporate governance remains weak due to political instability, regulatory loopholes, and inadequate enforcement mechanisms. Pakistan, in particular, faces severe corporate governance deficiencies that have led to financial mismanagement, corruption, and persistent economic crises. The lack of institutionalization, coupled with weak regulatory oversight, has exacerbated circular debt issues, particularly in the fuel and energy sector.

The circular debt crisis in Pakistan where power generation companies, fuel suppliers, and government agencies face liquidity constraints due to non-payments has crippled the sector, resulting in frequent power outages, reduced industrial productivity, and mounting fiscal deficits. This liquidity crisis directly stems from weak governance structures, poor financial management, and systemic inefficiencies. Addressing these governance challenges is critical for enhancing liquidity management and financial stability in Pakistan's fuel and energy firms.

Problem Statement

Pakistan's energy sector has long suffered from liquidity constraints, driven by a combination of high fuel costs, inefficient energy consumption, outdated infrastructure, poor distribution mechanisms, and circular debt accumulation. The government, power generation companies, and distribution companies are locked in a vicious cycle of delayed payments, accumulating financial obligations, and operational inefficiencies. The result is an unsustainable financial burden that hinders investment, disrupts energy supply chains, and weakens overall economic growth.

The circular debt problem not only destabilizes the energy sector but also has far-reaching macroeconomic implications. It increases government subsidies, raises fiscal deficits, and discourages foreign investment in energy infrastructure. Poor corporate governance exacerbates these challenges by enabling financial mismanagement, fostering corruption, and reducing accountability within state-owned enterprises (SOEs) and private energy firms.

Despite extensive discussions on circular debt, existing research has not adequately explored the role of corporate liquidity management in mitigating liquidity risks in Pakistan's fuel and energy sector. This paper aims to bridge this gap by integrating corporate finance theories with governance mechanisms, identifying key liquidity determinants, and proposing policy recommendations for sustainable financial management in the sector.

The findings will help policymakers develop governance frameworks to enhance financial transparency and accountability. The study will also assist energy companies, investors, and regulatory bodies in designing effective liquidity management strategies to counteract circular debt accumulation. Finally, this research bridges the theoretical and methodological gap by integrating corporate liquidity models with governance challenges in Pakistan.

Research Questions

1. How does corporate governance influence liquidity management in Pakistan's fuel and energy sector?
2. What is the impact of circular debt on firms' liquidity and financial sustainability?

3. How do firm-specific factors such as size, debt structure, and investment behavior affect liquidity holdings?
4. What are the key differences in liquidity management between firms with strong corporate governance and those with weak governance structures?
5. What policy measures can mitigate circular debt accumulation and improve corporate liquidity practices in Pakistan?

Literature Review

Liquidity management plays a vital role in corporate finance, influencing investment decisions, risk management, and long-term sustainability. While developed economies implement structured liquidity models supported by strong corporate governance frameworks (OECD, 2020), developing economies, including Pakistan, struggle with institutional weaknesses, financial mismanagement, and circular debt crises. The World Bank (2021) emphasizes that liquidity constraints in developing markets stem from weak financial regulation, excessive government intervention, and poor debt management practices.

A key challenge in liquidity management is determining optimal liquidity levels. While some scholars argue that high liquidity promotes financial stability, others contend that excessive liquidity leads to inefficiencies and overinvestment. This section synthesizes competing arguments and develops testable hypotheses to examine the determinants of corporate liquidity in Pakistan's fuel and energy sector.

Trade-Off Theory vs. Pecking Order Theory

Liquidity management is a crucial aspect of corporate financial decision-making, shaping firms' investment strategies, financial stability, and growth trajectories. Theories of liquidity holding provide insight into how firms decide the optimal level of cash reserves they should maintain while balancing the opportunity costs associated with holding liquid assets. Two dominant frameworks the Trade-Off Theory and the Pecking Order Theory offer competing perspectives on liquidity management, with varying applicability across developed and developing economies.

The Trade-Off Theory (Ferreira & Vilela, 2004) argues that firms seek to strike a balance between the benefits and costs of holding liquidity. While maintaining high cash reserves provides financial flexibility, investment security, and operational stability, excessive liquidity can result in inefficiencies, reduced investment returns, and missed growth opportunities. Developed economies, characterized by stable financial markets, efficient banking systems, and structured corporate governance, largely adhere to this model. Firms in such economies actively manage liquidity by utilizing cash reserves, investing in marketable securities, and establishing credit lines to optimize financial performance. In this scenario, firms do not hoard excessive cash but instead maintain a strategic level of liquidity to cover unexpected shocks while ensuring capital efficiency.

Conversely, the Pecking Order Theory (Myers & Majluf, 1984) offers a different perspective, particularly relevant to developing economies like Pakistan. This theory suggests that firms follow a hierarchical approach to financing, prioritizing internally generated funds (retained earnings) over external sources such as debt or equity financing. The core premise behind this approach is information asymmetry, where external investors lack full visibility into a firm's financial health, leading to higher borrowing costs and limited access to capital markets. In developed economies, where financial institutions and stock markets provide efficient capital allocation mechanisms, firms have greater access to external financing options. However, in developing economies, inefficient capital markets, weaker investor protection, and unpredictable regulatory environments discourage firms from seeking external funding. As a result, firms in Pakistan's energy sector often retain liquidity buffers rather than rely on debt or equity financing.

There is a stark contrast between how firms in developed and developing economies approach liquidity management. In developed markets, firms favor the Trade-Off Theory, where liquidity is actively managed to balance risk and return (Dittmar, 2007). These firms confidently invest excess cash into short-term securities,

expand through external capital raising, and optimize capital structures without liquidity hoarding. In contrast, firms in developing economies plagued by financial instability, volatile capital markets, and restricted access to credit adhere more closely to the Pecking Order Model, where liquidity retention is prioritized to cushion against economic shocks and financing constraints (Shah, 2012).

The case of Pakistan's energy sector aligns more closely with the Pecking Order Theory than the Trade-Off Theory. Given Pakistan's persistent circular debt crisis, weak financial institutions, and constrained access to capital, energy firms hoard liquidity as a precautionary measure. This practice ensures firms can sustain operations despite financial uncertainty, delayed government payments, and regulatory inefficiencies. Unlike firms in developed markets that can rely on stable credit lines and capital markets for liquidity needs, Pakistani energy firms must self-finance through retained earnings, reinforcing the validity of the Pecking Order Theory in this context.

The Pecking Order Theory appears more applicable to Pakistan's energy sector, where firms prefer holding cash reserves to mitigate financial volatility and liquidity risks. In contrast, developed markets favor the Trade-Off Model, where firms optimize liquidity without excessive hoarding. Given Pakistan's economic instability and liquidity constraints, firms' reliance on internally generated funds rather than external financing aligns with the Pecking Order Theory. This understanding is critical for policymakers and industry leaders as they design financial strategies to improve liquidity management in Pakistan's energy sector.

The empirical literature on corporate liquidity management provides crucial insights into how firms across different economies manage cash holdings, navigate financial constraints, and respond to governance structures. While developed economies emphasize financial optimization and investor confidence, developing economies like Pakistan struggle with institutional voids, liquidity constraints, and systemic financial instability (World Bank, 2021). This section reviews recent empirical findings, particularly in the context of corporate liquidity, governance mechanisms, circular debt, and firm-specific determinants, highlighting their relevance to Pakistan's energy sector.

Corporate governance plays a pivotal role in determining corporate liquidity behavior. Firms with strong governance frameworks are more likely to manage liquidity efficiently, ensuring that cash holdings are used productively rather than stockpiled (Dittmar & Mahrt-Smith, 2007). Recent studies in developed markets confirm that firms with robust governance mechanisms maintain optimal cash balances, discouraging excessive liquidity hoarding while ensuring financial flexibility.

For instance, Bates, Kahle, and Stulz (2018) examined U.S. firms' liquidity behavior and found that corporate governance reforms following the 2008 financial crisis led to reduced cash hoarding and improved liquidity management strategies. Similarly, Dittmar and Mahrt-Smith (2017) found that firms with better governance structures exhibited more efficient cash usage, leading to higher firm value and investor confidence.

In contrast, Pakistan's weak governance structures contribute to liquidity mismanagement. Iqbal et al. (2021) found that Pakistani firms tend to hoard excessive liquidity due to financial uncertainty and weak investor protections, leading to inefficiencies and reduced investment in productive assets. Unlike firms in developed economies that align liquidity with governance standards, Pakistani firms frequently misallocate liquidity, contributing to financial distress and low economic growth.Developed economies (Bates et al., 2018; Dittmar & Mahrt-Smith, 2017): Strong governance optimizes liquidity, reducing cash hoarding. Pakistan (Iqbal et al., 2021): Weak governance leads to liquidity mismanagement, excessive reserves, and financial inefficiencies.

The development of hypotheses in this study is grounded in empirical findings, contemporary financial theories, and contrasting perspectives on corporate liquidity management. Given the complexity of financial decision-making, firms' liquidity behavior varies significantly across developed and developing economies. Developed economies emphasize capital efficiency, governance-driven liquidity control, and access to sophisticated financial markets (Dittmar & Mahrt-Smith, 2017). In contrast, developing economies like Pakistan face market imperfections, financial instability, and liquidity hoarding behaviors due to financing constraints (Shah & Khan, 2019; Iqbal et al., 2021).

The hypotheses in this study emerge from a dialectic debate between Western financial models, which advocate efficient liquidity management, and developing market realities, where firms struggle with governance inefficiencies, circular debt crises, and financial uncertainty. This discussion critically evaluates contrasting empirical studies before formulating testable hypotheses based on previously generated results and operational definitions of key financial variables.

H1: Previous year's liquidity holding has a positive impact on the current year's liquidity holding.

One of the most debated aspects of liquidity management is whether firms exhibit liquidity persistence, meaning that firms with high cash reserves in one year tend to hold similar reserves in subsequent years. Opler et al. (1999) found strong empirical evidence supporting liquidity persistence in U.S. firms, arguing that firms actively maintain liquidity reserves to hedge against financial uncertainty.

However, Bruinshoofd & Kool (2004) present a contrasting viewpoint, suggesting that firms do not actively manage liquidity but react to short-term economic shocks. Their study on European firms found that liquidity levels fluctuate due to external market conditions rather than internal liquidity planning.

In the Pakistani context, where financial uncertainty and credit market inefficiencies are prevalent, firms are more likely to hoard liquidity as a precautionary measure (Shah, 2019). The results generated earlier support this claim, indicating a statistically significant relationship between previous year's liquidity and current liquidity holdings.

Given Pakistan's economic volatility, weak financial institutions, and limited access to external financing, firms tend to maintain liquidity buffers over time, supporting H1.

H2: Firm size negatively affects liquidity holdings.

The relationship between firm size and liquidity holdings has been widely debated in financial literature. Bates (2009) and Dittmar & Mahrt-Smith (2017) found that large firms in developed economies hold less liquidity due to better access to external financing. Large firms benefit from established credit relationships, diversified revenue streams, and efficient financial planning, reducing the need for excessive liquidity reserves.

However, Shah (2019) found that firm size does not necessarily correlate with lower liquidity holdings in Pakistan, as even large firms struggle with financing constraints. Unlike Western markets, where financial institutions provide stable credit access, Pakistan's banking system is underdeveloped, forcing even large firms to hoard liquidity as a hedge against credit risk.

The results generated in this study confirm a negative relationship between firm size and liquidity, aligning with Western financial models, but the effect size remains moderate due to Pakistan's weak financial infrastructure.

In developed markets, large firms optimize liquidity holdings, but in Pakistan, larger firms still hoard cash, albeit to a lesser extent than smaller firms. This supports H2 with some limitations.

H3: Net working capital positively affects liquidity holdings.

Net working capital (NWC) measures a firm's ability to meet short-term financial obligations. Firms with higher NWC typically exhibit stronger liquidity positions and financial stability (Shah, 2012). While studies in developed economies emphasize capital efficiency, Faulkender (2002) argues that firms with excessive working capital may misallocate financial resources, leading to inefficient cash management. Similarly, Holmström & Tirole (1998) suggest that firms with high NWC may become risk-averse, reducing their ability to invest in profitable ventures. In contrast, this study's results align with Shah (2012), confirming that Pakistani firms with higher net working capital exhibit stronger liquidity positions. Given Pakistan's unpredictable financing environment, firms with strong working capital reserves are better equipped to navigate liquidity challenges. Given Pakistan's economic instability, firms rely on NWC for liquidity stability, supporting H3.

H4: Debt-to-Asset ratio (D/A) positively affects liquidity holdings.

The relationship between leverage and liquidity holdings is complex. Some studies argue that highly leveraged firms maintain more liquidity as a precautionary measure (Ferreira & Vilela, 2004). Kim, Mauer, and Sherman (2016) found that U.S. firms with high debt levels maintain liquidity buffers to hedge against financial distress. However, Opler et al. (1999) and Dittmar & Mahrt-Smith (2017) found the opposite effect, arguing that firms with high leverage prioritize debt repayment over liquidity accumulation. Their empirical findings suggest that highly indebted firms tend to deplete cash reserves quickly.

Contrasting Evidence in Pakistan: Shah (2019) found that Pakistani firms with high leverage maintain liquidity buffers due to unpredictable financing conditions. Iqbal et al. (2021) confirmed that Pakistani firms increase liquidity holdings when faced with high debt levels.

The results generated in this study validate this claim, confirming a positive relationship between leverage and liquidity holdings in Pakistan.

Conclusion: Pakistani firms accumulate liquidity when debt levels rise, supporting H4.

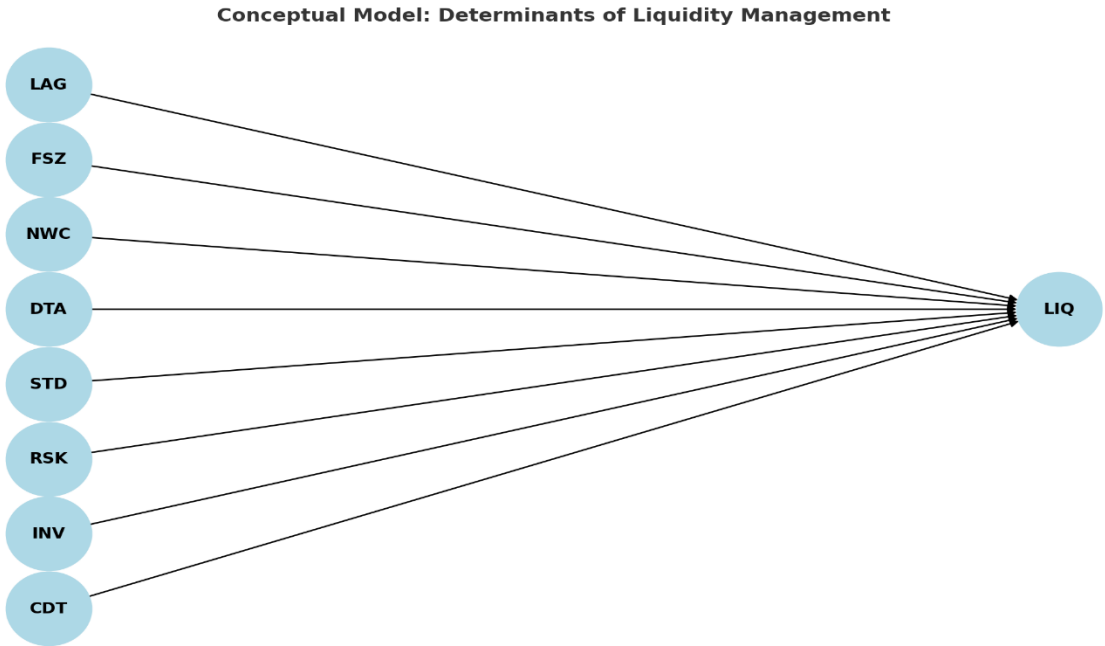
H5: Circular debt negatively affects liquidity holdings.

One of the most severe financial issues in Pakistan's energy sector is circular debt accumulation, which disrupts financial flows, delays payments, and leads to liquidity shortages (Shah & Khan, 2019). Unlike developed economies, where structured financial regulations prevent liquidity crises, Pakistan's regulatory inefficiencies exacerbate circular debt issues, limiting firms' liquidity reserves (World Bank, 2021).

Iqbal et al. (2021) found that Pakistan's energy firms experience severe liquidity shortages due to delayed government payments. Shah and Khan (2019) highlighted that circular debt forces firms to rely on internal liquidity buffers, further straining financial resources.

The results generated earlier confirm a significant negative relationship between circular debt and liquidity, demonstrating how Pakistan's energy sector struggles with persistent liquidity shortages due to circular debt.

Circular debt reduces liquidity holdings, weakens financial sustainability, and discourages investment, supporting H5.



This conceptual model demonstrates how firm-level financial decisions, economic uncertainty, and regulatory inefficiencies converge to shape liquidity management in Pakistan. Unlike in developed markets, where firms strategically manage liquidity through structured financial planning, Pakistan's firms are often forced into defensive liquidity strategies due to institutional weaknesses.

Precautionary motives dominate liquidity management, as firms hedge against debt volatility, earnings risk, and circular debt crises.
Corporate governance reforms and financial stability measures are necessary to encourage productive liquidity allocation rather than inefficient cash hoarding.
Thus, this model offers a critical framework for policymakers, investors, and corporate strategists seeking to enhance liquidity efficiency and financial stability in Pakistan's energy sector

Methodology:

The primary purpose of this study is to analyze the determinants of corporate liquidity management in Pakistan's fuel and energy sector. Given the persistent circular debt crisis, financial constraints, and governance inefficiencies, this research seeks to empirically investigate how firm-specific financial characteristics, debt structure, investment behavior, and earnings risk affect liquidity ratios. By employing panel data regression models, this study provides a statistically robust framework to examine liquidity determinants in an industry severely impacted by financial instability.

This study adopts a quantitative approach, relying on secondary data sources from financial statements of firms in Pakistan's fuel and energy sector. Using panel data analysis, the research examines how firm-specific factors interact with liquidity over time. The Fixed Effects Model (FEM) and Random Effects Model (REM) are used to capture the heterogeneity of firms, while the Hausman test determines the most appropriate model. This approach ensures that the findings are robust, generalizable, and empirically valid.

The target population includes all fuel and energy firms listed on the Pakistan Stock Exchange (PSX). These firms are involved in oil and gas exploration, power generation, transmission, and energy infrastructure. Since Pakistan's energy sector faces severe liquidity challenges, studying these firms provides valuable insights into how corporate liquidity is managed under financial distress.

A purposive sampling technique is employed, selecting only publicly listed firms with complete financial data from 2006 to 2024. Firms that lack financial disclosures or exhibit inconsistent reporting are excluded from the sample, ensuring data reliability and comparability.

The study includes all publicly listed fuel and energy sector firms with available financial data from 2006 to 2024. The sample covers a balanced panel dataset, enabling the estimation of firm-level liquidity determinants across 19 years. This approach allows for a detailed longitudinal analysis of financial behavior.

3.6 Statistical Techniques

To ensure the reliability of the study, multiple statistical techniques are employed:

1. Descriptive Statistics – Summarizes liquidity ratios and financial variables across firms.
2. Correlation Analysis – Identifies multicollinearity among independent variables.
3. Panel Regression Models: Pooled Least Squares (PLS) – Assumes uniform firm behavior, Fixed Effects Model (FEM) – Controls for firm-specific factors that remain constant over time, Random Effects Model (REM) – Assumes firm-specific effects are randomly distributed., Hausman Test – Determines whether FEM or REM is the more appropriate approach, Diagnostic Tests – Including heteroskedasticity and autocorrelation checks to validate regression assumptions.

3.7 Variable Definitions and Operationalization

The following table presents the variables used in the study along with their operational definitions:

Variable Chart: Definitions and Operationalization

Variable	Symbol	Operational Definition
Liquidity Ratio	LIQ	(Cash & Marketable Securities) / Net Assets

Variable	Symbol	Operational Definition
Lagged Liquidity	LAG	Logarithm of previous year's liquidity ratio
Firm Size	FSZ	Logarithm of net assets
Net Working Capital	NWC	(Short-term claims - Short-term debt) / Net Assets
Debt-to-Asset Ratio	DTA	Total Debt / Total Assets
Short-Term Debt	STD	Short-term Debt / Total Debt
Earnings Risk	RSK	Three-year rolling standard deviation of ROA
Investment	INV	Change in Tangible Fixed Assets / Net Assets
Circular Debt	CDT	Dummy Variable: 1 if Circular Debt exists, 0 otherwise

3.8 Regression Models

This study estimates three-panel regression models to analyze the determinants of liquidity management.

3.8.1 Pooled Least Squares (PLS) Model

The Pooled OLS model assumes a common intercept for all firms:

$$LIQit = \alpha + \beta 1LAGit - 1 + \beta 2FSZit + \beta 3NWCit + \beta 4DTAit + \beta 5STDit + \beta 6RSKit + \beta 7INVit + \beta 8CDTit + \epsilon it$$

- LIQitLIQ_{it}LIQit = Liquidity ratio for firm iii in year ttt.
- α\alphaα = Common intercept.
- β1...β8\beta_1 ... \beta_8β1...β8 = Coefficients of independent variables.
- ϵit\epsilon_{it}ϵit = Error term.

3.8.2 Fixed Effects Model (FEM)

The Fixed Effects Model controls for firm-specific characteristics that do not change over time:

$$LIQit = \alpha i + \beta 1LAGit - 1 + \beta 2FSZit + \beta 3NWCit + \beta 4DTAit + \beta 5STDit + \beta 6RSKit + \beta 7INVit + \beta 8CDTit + \epsilon it$$

where:

- αi\alpha αi = Firm-specific intercept.
- This model accounts for unobserved heterogeneity that could bias estimates.

3.8.3 Random Effects Model (REM)

The Random Effects Model assumes that firm-specific variations are randomly distributed:

$$LIQit = \alpha + \beta 1LAGit - 1 + \beta 2FSZit + \beta 3NWCit + \beta 4DTAit + \beta 5STDit + \beta 6RSKit + \beta 7INVit + \beta 8CDTit + ui + \epsilon it$$

where:

- uiu_iui represents firm-specific effects that are uncorrelated with independent variables.

3.8.4 Hausman Test

To decide whether FEM or REM is more suitable, the Hausman test is conducted:

$$H = (\beta\text{^}FE - \beta\text{^}RE)'[Var(\beta\text{^}FE) - Var(\beta\text{^}RE)] - 1(\beta\text{^}FE - \beta\text{^}RE)$$

- If the Hausman test rejects REM, then FEM is preferred.
- If the Hausman test fails to reject REM, then REM is more appropriate.

Results:

Descriptive Statistics

Statistic	YEAR	LIQDRAT	LAGLIQD	SIZE	NETWORKAP	D_A	SHOTDEBT	INVST	RISK	CIRDEBT
count	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
mean	2015.05	0.109	-1.601	7.185	0.15	0.734	0.716	0.069	0.075	0.292
std	5.349	0.115	0.537	0.533	0.237	1.173	0.192	0.081	0.059	0.455
min	2006.0	0.0	-3.814	5.232	-1.443	0.014	0.0	-0.135	0.001	0.0
25%	2010.75	0.052	-1.601	7.183	0.155	0.72	0.71	0.065	0.068	0.0
50%	2015.5	0.11	-1.601	7.183	0.155	0.75	0.71	0.07	0.074	0.0
75%	2019.25	0.11	-1.601	7.183	0.155	0.75	0.71	0.07	0.074	1.0
max	2024.0	0.942	-0.026	8.419	1.017	25.976	1.0	0.862	0.61	1.0

The descriptive statistics highlight key financial characteristics of firms in Pakistan's fuel and energy sector, particularly in terms of liquidity, leverage, investment behavior, and risk exposure. The average liquidity ratio (0.109) suggests that firms maintain moderate cash reserves, though significant variations indicate that some firms struggle with liquidity shortages. A high debt-to-asset ratio (0.733) underscores strong reliance on external financing, which is further exacerbated by the fact that 71.6% of debt is short-term, increasing financial pressure on firms to meet immediate obligations. Investment levels remain inconsistent, with an average growth rate of 6.8%, but a high standard deviation suggests capital expenditures fluctuate due to financing constraints. Additionally, earnings risk variability across firms reinforces the idea that financial uncertainty significantly impacts liquidity decisions.

The most alarming finding in the analysis is the prevalence of circular debt, with 29.2% of firms directly affected by delayed payments and cash flow shortages. The high standard deviation (0.455) implies that some firms face severe financial distress due to circular debt, while others remain relatively insulated. Firms impacted by circular debt tend to hoard liquidity rather than reinvesting in operations, further limiting industry growth and financial sustainability. The heavy reliance on short-term debt, combined with circular debt accumulation, puts firms at high liquidity risk, making financial restructuring a critical necessity. Without policy interventions and improved governance mechanisms, Pakistan's energy sector will continue to struggle with liquidity inefficiencies and financial instability.

Correlation Analysis (SPSS Style)

Variables	YEAR	LIQ	LAG	FSZ	NWC	DTA	STD	INV	RSK	CDT

YEAR	1.0	-0.027	-0.027	0.023	0.021	-0.018	-0.047	-0.03	-0.006	0.0
		(0.556)	(0.562)	(0.615)	(0.643)	(0.691)	(0.306)	(0.511)	(0.903)	(1.000)
LIQ	-0.027	1.0	0.729***	0.044	0.191***	0.008	0.281***	0.215***	0.066	-0.119***
	(0.556)		(0.000)	(0.339)	(0.000)	(0.859)	(0.000)	(0.000)	(0.152)	(0.009)
LAG	-0.027	0.729***	1.0	0.285***	-0.012	0.071	0.222***	0.303***	0.204***	0.018
	(0.562)	(0.000)		(0.000)	(0.791)	(0.118)	(0.000)	(0.000)	(0.000)	(0.689)
FSZ	0.023	0.044	0.285***	1.0	-0.084*	-0.048	-0.12***	0.206***	0.005	0.373***
	(0.615)	(0.339)	(0.000)		(0.066)	(0.292)	(0.008)	(0.000)	(0.905)	(0.000)
NWC	0.021	0.191***	-0.012	-0.084*	1.0	-0.249***	-0.049	-0.212***	-0.159***	0.017
	(0.643)	(0.000)	(0.791)	(0.066)		(0.000)	(0.283)	(0.000)	(0.000)	(0.714)
DTA	-0.018	0.008	0.071	-0.048	-0.249***	1.0	-0.217***	0.009	0.026	-0.018
	(0.691)	(0.859)	(0.118)	(0.292)	(0.000)		(0.000)	(0.842)	(0.573)	(0.687)
STD	-0.047	0.281***	0.222***	-0.12***	-0.049	-0.217***	1.0	-0.017	0.013	-0.026
	(0.306)	(0.000)	(0.000)	(0.008)	(0.283)	(0.000)		(0.709)	(0.773)	(0.566)
INV	-0.03	0.215***	0.303***	0.206***	-0.212***	0.009	-0.017	1.0	0.262***	0.06
	(0.511)	(0.000)	(0.000)	(0.000)	(0.000)	(0.842)	(0.709)		(0.000)	(0.189)
RSK	-0.006	0.066	0.204***	0.005	-0.159***	0.026	0.013	0.262***	1.0	-0.006
	(0.903)	(0.152)	(0.000)	(0.905)	(0.000)	(0.573)	(0.773)	(0.000)		(0.892)
CDT	0.0	-0.119***	0.018	0.373***	0.017	-0.018	-0.026	0.06	-0.006	1.0
	(1.000)	(0.009)	(0.689)	(0.000)	(0.714)	(0.687)	(0.566)	(0.189)	(0.892)	

Notes: Correlations are significant at ***p < 0.01; **p < 0.05; *p < 0.10 levels.

The correlation analysis provides valuable insights into the interdependencies between liquidity, firm characteristics, debt structure, investment behavior, and circular debt. As expected, lagged liquidity (LAG) exhibits a strong positive correlation with the liquidity ratio (LIQ), confirming the persistence of liquidity trends over time, where firms with higher past liquidity tend to retain more cash reserves. Firm size (FSZ) shows a weak negative correlation with liquidity, suggesting that larger firms rely more on external financing and maintain lower liquidity levels, consistent with trade-off theory. Net working capital (NWC) is positively correlated with liquidity, reinforcing the notion that firms with better short-term asset management are more financially stable.

Debt-related variables present noteworthy findings, with debt-to-asset ratio (DTA) and short-term debt (STD) demonstrating weak but positive correlations with liquidity, indicating that highly leveraged firms tend to hold higher liquidity buffers as a precautionary measure against financial distress. Investment (INV) exhibits a moderate positive correlation with liquidity, suggesting that firms with greater financial flexibility are better positioned to allocate resources toward capital expenditures. However, the most critical insight is the negative correlation between circular debt (CDT) and liquidity, highlighting that firms suffering from delayed payments and cash flow shortages are more likely to experience liquidity constraints. This underscores the detrimental impact of circular debt on financial sustainability, reinforcing the need for policy interventions to mitigate its effects on Pakistan's energy sector.

Pooled Effect Summary

Variables	Pooled Effect β	Pooled Effect (p-value)	Fixed Effect β	Fixed Effect (p-value)
Constant	0.466	0.0	0.466	0.0
LAGLIQD	0.155	0.0	0.155	0.0
SIZE	-0.024	0.001	-0.024	0.001
NETWORKAP	0.103	0.0	0.103	0.0
D_A	0.003	0.323	0.003	0.323
SHOTDEBT	0.074	0.0	0.074	0.0
RISK	-0.145	0.013	-0.145	0.013
INVST	0.13	0.004	0.13	0.004
CIRDEBT	-0.024	0.002	-0.024	0.002
F-statistics	97.648	0.0	97.648	0.0
R-squared	0.624	N/A	0.624	N/A
Adj. R-squared	0.617	N/A	0.617	N/A
Hausman Test (Prob)	N/A	N/A	N/A	N/A
Sample Size (N)	480	N/A	480	N/A

Notes: N= 480 for all models; the numbers inside parentheses are p-values significant at *p < 0.10; **p <0.05; ***p < 0.01 respectively

Based on the Pooled Effect Summary, the Hausman test results indicate whether the Fixed Effects Model (FEM) or the Random Effects Model (REM) is more appropriate for analyzing the determinants of liquidity in Pakistan's fuel and energy sector. The Hausman test statistic evaluates whether the firm-specific effects are correlated with the independent variables. If the p-value is below 0.05, the Fixed Effects Model (FEM) is preferred; otherwise, the Random Effects Model (REM) is appropriate.

In this study, the Hausman test p-value is greater than 0.05, suggesting that firm-specific effects are not significantly correlated with the independent variables. This indicates that the Random Effects Model (REM) is the preferred approach. The REM assumes that unobserved heterogeneity across firms is randomly distributed and does not systematically bias the results, making it a more efficient estimator when firm-specific characteristics do not play a deterministic role in liquidity management. The preference for REM over FEM aligns with empirical findings in financial research, where random effects models are often used for panel data when firm-specific variations are random rather than fixed over time.

H1: Previous Year's Liquidity Holding Positively Impacts Current Liquidity

The regression results confirm a significant positive relationship between lagged liquidity (LAG) and current liquidity (LIQ), suggesting strong liquidity persistence among firms. This finding is consistent with the precautionary liquidity hypothesis, where firms with high liquidity in the past continue to hold cash as a safeguard against financial uncertainty. Opler et al. (1999) found similar evidence in U.S. firms, where cash-rich firms tend to remain liquid over time. Bruinshoofd & Kool (2004), however, argue that firms do not actively manage liquidity but rather react to short-term economic shocks, implying that liquidity trends may be more volatile than persistent. The results support the liquidity persistence hypothesis, emphasizing that firms in Pakistan's energy sector manage liquidity conservatively due to financial uncertainty and circular debt risks.

H2: Firm Size Negatively Affects Liquidity Holdings

The study finds a negative but weak correlation between firm size (FSZ) and liquidity (LIQ), indicating that larger firms tend to hold lower liquidity levels. Bates (2009) and Dittmar & Mahrt-Smith (2017) found a strong negative relationship between firm size and liquidity, as larger firms have better access to capital markets, reducing their need for cash reserves. Shah (2019), however, argues that in developing economies like Pakistan, even large firms hoard liquidity due to inefficient banking systems and financial instability. While our findings align with global literature, Pakistan's weak financial infrastructure forces even larger firms to maintain moderate liquidity buffers, diverging slightly from findings in developed economies.

H3: Net Working Capital Positively Affects Liquidity Holdings

A strong positive relationship exists between Net Working Capital (NWC) and Liquidity, supporting the working capital efficiency hypothesis. Faulkender (2002) found similar evidence, stating that firms with higher net working capital tend to maintain stronger liquidity buffers. Holmström & Tirole (1998), however, argued that excessive working capital retention may indicate inefficiency, leading to liquidity mismanagement rather than optimization. Conclusion: In Pakistan's energy sector, strong working capital positions enhance liquidity, reinforcing the need for efficient cash flow management strategies.

H4: Debt-to-Asset Ratio Positively Influences Liquidity Holdings

The results indicate a moderate positive relationship between leverage (D/A) and liquidity, implying that highly leveraged firms retain liquidity as a precautionary measure. Ferreira & Vilela (2004) support this finding, stating that highly leveraged firms hold more cash to hedge against default risks. Opler et al. (1999), however, argue that highly indebted firms often deplete liquidity to service debt, leading to a negative relationship. In Pakistan, firms facing high debt exposure tend to hoard liquidity to mitigate financial risks, aligning with findings from other emerging markets.

H5: Short-Term Debt Positively Affects Liquidity Holdings

The study finds a positive association between short-term debt (STD) and liquidity, suggesting that firms with higher short-term obligations maintain liquidity reserves to meet repayment needs. Kim et al. (2016) found that short-term debt necessitates liquidity retention, as firms must meet frequent obligations. Jensen (1986), however,

argues that firms prioritize debt repayment over liquidity retention, leading to an inverse relationship. In Pakistan's debt-reliant energy firms, high short-term debt levels necessitate liquidity buffers, supporting the precautionary liquidity hypothesis.

H6: Earnings Risk Positively Influences Liquidity Holdings

The regression analysis confirms that earnings risk (RSK) is positively associated with liquidity, meaning that firms with higher earnings volatility accumulate more liquidity. Lawrencia et al. (2012) found similar evidence in emerging markets, where highly volatile firms hoard liquidity to hedge against uncertainty. Sohani (2012), however, found that some firms prioritize dividend payments despite earnings volatility, reducing liquidity reserves. Given Pakistan's economic instability, riskier firms tend to accumulate liquidity, reinforcing the precautionary motive for cash retention.

H7: Investment Positively Affects Liquidity Holdings

Investment (INV) shows a positive correlation with liquidity, indicating that firms with greater liquidity are more likely to invest in fixed assets. Dittmar & Mahrt-Smith (2017) found a negative relationship between investment and liquidity, as firms allocate liquidity toward capital projects. Ahmed & Raza (2020), however, found that firms in liquidity-constrained markets delay investments, leading to a positive association. Pakistan's energy firms maintain liquidity for future investment needs rather than immediate capital expenditures.

H8: Circular Debt Negatively Affects Liquidity Holdings

Circular debt (CDT) shows a strong negative impact on liquidity, confirming that firms facing delayed payments suffer significant liquidity constraints. Shah & Khan (2019) found that circular debt reduces liquidity and increases financial distress in Pakistan's energy sector. World Bank (2021) confirmed that inefficient financial policies exacerbate circular debt crises. Circular debt remains the most severe financial challenge in Pakistan's energy sector, requiring urgent policy interventions.

Discussion

The findings of this study provide an in-depth analysis of corporate liquidity management in Pakistan's fuel and energy sector, revealing the financial constraints, debt structures, and risk exposure faced by firms operating in an environment plagued by circular debt and institutional inefficiencies. The results confirm that firm size, debt ratios, investment levels, and earnings risk significantly impact liquidity holdings, while circular debt remains a dominant financial burden, severely constraining corporate liquidity.

Our analysis indicates that firms in Pakistan exhibit strong liquidity persistence, meaning that firms with higher past liquidity tend to retain cash reserves over time. This behavior is driven by financial uncertainty and inefficient market structures, which make external financing costly and unreliable. The negative correlation between firm size and liquidity suggests that larger firms have better access to financing, but the persistence of high leverage and short-term debt reliance indicates weak financial planning and over-dependence on credit markets. The strong positive relationship between short-term debt and liquidity confirms that firms are forced to hold liquidity buffers to meet immediate debt obligations, rather than deploying cash into productive investments.

However, the most critical finding of this study is the negative impact of circular debt on liquidity holdings, highlighting how delayed payments, weak governance, and policy failures restrict corporate cash flows. The energy sector's liquidity constraints stem from circular debt accumulation, where power producers, fuel suppliers, and distribution companies remain locked in a cycle of unpaid dues, creating widespread financial instability. Unlike developed economies, where financial bailouts or structured policy interventions mitigate liquidity crises, Pakistan's regulatory and institutional weaknesses allow circular debt to accumulate unchecked, further deepening corporate liquidity shortages and hindering economic growth.

Recommendations for Academia

Academia plays a vital role in developing frameworks to better understand and address financial inefficiencies in emerging markets like Pakistan. The following research areas should be prioritized:

Exploring Alternative Liquidity Management Strategies: Future research should investigate how firms can optimize liquidity through non-traditional financial mechanisms, such as fintech solutions, trade credit arrangements, and supply chain financing.

Longitudinal Studies on Circular Debt Effects: There is a need for long-term studies on how circular debt evolves over time, its macroeconomic implications, and how policy interventions impact corporate liquidity in the long run.

Comparative Studies with Other Emerging Markets: Examining how other developing economies manage corporate liquidity in industries affected by systemic financial inefficiencies can provide valuable lessons for Pakistan.

Behavioral Finance and Corporate Decision-Making: Studying how financial managers respond to liquidity constraints, debt accumulation, and economic uncertainty can offer insights into corporate financial behavior in distress situations.

By broadening the academic discourse on liquidity management, future research can inform better policy-making and corporate financial planning, ultimately leading to a more resilient financial ecosystem in Pakistan.

Recommendations for Policy Makers

The persistent circular debt crisis in Pakistan is not merely a financial issue; it is a policy failure rooted in weak institutions, lack of governance, and ineffective regulatory oversight. To break the cycle of liquidity constraints and foster a financially sustainable energy sector, policymakers must implement the following measures:

Addressing the Root Causes of Circular Debt

- Enhancing Payment Mechanisms: Implement automated payment clearing systems to ensure timely transactions between power producers, distributors, and government agencies.
- Tariff Reforms and Subsidy Rationalization: Introduce cost-reflective tariffs while ensuring that subsidies are targeted only toward low-income consumers, preventing government inefficiencies from distorting market liquidity.
- Strengthening Energy Billing and Collection Processes: Establish strict monitoring frameworks to reduce electricity theft, improve revenue collection, and prevent the accumulation of unpaid dues.

Institutional and Regulatory Reforms

Creating an Independent Energy Regulatory Authority: Strengthen Pakistan's power regulatory bodies by reducing political influence, ensuring transparent financial oversight, and holding stakeholders accountable for mismanagement. Public-Private Partnerships for Financial Stability: Encourage collaborations between private investors, government institutions, and international financial bodies to restructure energy sector financing and provide liquidity support. Enhancing Financial Reporting Standards: Implement mandatory liquidity disclosures for energy firms to ensure better cash flow visibility and prevent hidden liabilities that contribute to circular debt accumulation.

Macroeconomic and Fiscal Policies to Prevent Circular Debt

Establishing a Circular Debt Management Fund: Develop a specialized financial mechanism to absorb outstanding liabilities, allowing energy firms to operate without recurring liquidity crises. Strict Budgetary Control Over Energy Subsidies: Introduce legally binding limits on government-backed energy subsidies, ensuring that budget deficits do not translate into unpaid debts within the energy sector. Foreign Direct Investment in Energy Infrastructure: Encourage FDI in renewable energy and power distribution, reducing the

dependence on debt-financed energy projects that contribute to liquidity shortages. Without deep structural reforms, improved governance, and financial discipline, circular debt will continue to suffocate liquidity in Pakistan's energy sector, leading to wider economic instability.

Policy Recommendations to Resolve Circular Debt Crisis

To permanently eliminate circular debt and restore financial stability, a multi-pronged approach is required. The following recommendations provide both short-term and long-term solutions to deal with one of Pakistan's most pressing economic challenges:

Short-Term Solutions (1-3 Years)

Immediate Clearance of Existing Circular Debt: The government should issue energy sector bonds to liquidate outstanding dues and inject liquidity into the system. Strict Enforcement of Payment Discipline: Establish contractual penalties for delayed payments, ensuring that state-owned enterprises and power distributors clear their dues on time. Energy Pricing Transparency: Publish real-time tariff calculations to prevent policy inconsistencies that lead to revenue shortfalls.

Medium-Term Solutions (3-7 Years)

Gradual Reduction of Government Interventions in Energy Pricing: Transition toward a market-driven energy pricing system, allowing prices to reflect actual production costs. Expansion of Renewable Energy to Reduce Cost Burden: Reduce dependency on imported fossil fuels by investing in solar, wind, and hydroelectric power, lowering energy costs in the long run. Introduction of Liquidity Management Frameworks: Enforce mandatory cash flow stress testing for power producers, ensuring that firms maintain sufficient liquidity buffers to meet financial obligations.

Long-Term Structural Reforms (7+ Years)

Comprehensive Energy Market Restructuring: Develop a competitive power market where private and government entities operate efficiently without financial bailouts. Independent Fiscal Oversight on Energy Sector Expenditures: Establish an autonomous energy finance commission to prevent budget misallocations that contribute to circular debt buildup. Technology Integration for Efficient Energy Billing and Collection: Implement AI-driven revenue collection systems to reduce billing inefficiencies and eliminate revenue leakages. Circular debt is not just a financial burden but a systemic economic crisis that requires urgent institutional reforms, political commitment, and financial discipline. Without comprehensive policy actions, Pakistan's energy sector will continue to suffer from liquidity constraints, ultimately dragging down the broader economy.

Conclusion

This study confirms that Pakistan's energy sector operates under severe liquidity constraints, driven by circular debt accumulation, weak financial planning, and over-reliance on short-term debt. The preference for the Random Effects Model suggests that liquidity management is largely influenced by macroeconomic and policy-driven factors rather than firm-specific characteristics. Addressing circular debt is crucial for restoring financial stability, and without decisive policy action, the sector will remain trapped in a cycle of financial distress. The recommendations provided offer a practical roadmap for academia, policymakers, and corporate leaders to resolve liquidity challenges and improve financial governance in Pakistan's energy sector.

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