

Liquidity Management Practices Under Energy Uncertainty: An Empirical Investigation In Pakistan

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Abstract

This study examines the impact of energy-related uncertainty on liquidity management practices in Pakistani firms. Utilizing a comprehensive panel dataset of 290 non-financial companies from 2010 to 2022, we employ the energy-related uncertainty (EU) Index developed by Dang et al. (2023) to evaluate the influence of EU on corporate cash holdings. Our panel regression analysis, which includes firm-fixed effects, reveals that a 1% increase in ¹EU leads to a 0.38% increase in cash holdings. These findings underscore the precautionary motive for holding cash, as firms seek to buffer against the risks associated with energy price fluctuations. This research provides valuable insights for policymakers and business leaders to develop more stable energy policies and robust liquidity management strategies in response to energy market volatility.

JEL Classification: C33, D81, E22, G32, O16, Q41

Keywords: Energy Uncertainty, Corporate Cash Holdings, Liquidity Management, Financial Strategy, Pakistan, Developing Economies

1 Introduction

In the contemporary global economy, energy uncertainty has emerged as a pivotal factor influencing corporate decision-making processes. The volatility in energy prices and the unpredictability of energy policies can create substantial challenges for firms, particularly in developing economies like Pakistan. This study investigates the impact of energy-related uncertainty on liquidity management practices within Pakistani firms, providing empirical evidence to understand how businesses navigate such a volatile environment.

Energy markets are inherently volatile due to various factors, including geopolitical events, regulatory changes, and supply-demand imbalances. The uncertainty surrounding energy prices can significantly affect corporate financial strategies, particularly liquidity management, which is crucial for maintaining operational stability and funding investment opportunities. Liquidity management, which involves the strategic control of cash flow and liquid assets, is essential for firms to meet short-term obligations and ensure financial flexibility. The strategic management of liquidity allows firms to maintain a buffer against financial distress, particularly in unpredictable economic environments.

An essential component of corporate financial strategy is the management of short-term liquidity, which has a direct impact on a company's capacity to pay short-term debt and make investments in expansion prospects. Excess cash holdings have become an important component in this setting, giving businesses protection against low liquidity and financial

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difficulties. With an emphasis on Pakistani companies specifically, this study attempts to look into the reasons why companies choose to hold onto extra cash. For businesses, liquidity management is crucial, particularly in emerging nations like Pakistan where significant risks can arise from economic and market volatility. Holdings of excess cash provide businesses with a safety net that helps them deal with uncertain situations better. New research indicates that companies hoard cash for a number of reasons, such as agency concerns, transaction cost reduction, and precautionary purposes (Chen, Dou, Rhee, Truong, & Veeraraghavan, 2020; Pinkowitz, Stulz, & Williamson, 2016).

Pakistan provides a compelling context for studying the impact of energy uncertainty on liquidity management due to its unique economic and energy landscape. The country has faced significant energy challenges, including frequent power shortages, fluctuating energy prices, and policy instability. These issues have profound implications for corporate financial strategies, making Pakistan an ideal setting to explore how firms manage liquidity in response to energy-related uncertainties. The energy sector in Pakistan is characterized by its heavy reliance on imported energy, primarily oil and gas. This dependency exposes the country to global energy market fluctuations, impacting domestic energy prices and availability. Additionally, Pakistan's energy policies have often been inconsistent, with frequent changes in regulations and tariffs adding to the uncertainty faced by firms. These factors collectively create an environment where energy uncertainty is a significant concern for businesses, necessitating effective liquidity management strategies.

The purpose of this study is to investigate how does energy uncertainty influence liquidity management practices in Pakistani firms? Consequently, we hypothesize that the increased energy uncertainty leads to more conservative liquidity management practices among Pakistani firms. In order to investigate the cash holding practices of non-financial companies in Pakistan, we have used a comprehensive panel dataset consisting of 290 firms from 2010 to 2022, which includes 4,921 year-end observations. The ratio of total non-cash assets to the sum of cash and short-term bank deposits is used to calculate cash holdings. Our analysis uses the energy-related uncertainty (EU) Index, which was recently developed by Dang et al. (2023), to evaluate the impact of EU on company liquidity decisions. The panel regression model is chosen for its ability to account for both time-series and cross-sectional variations in the data. This approach allows us to control for unobserved heterogeneity across firms and over time, providing more robust estimates of the impact of energy uncertainty on liquidity management. Additionally, the use of firm-fixed effects in the regression model helps to control for time-invariant firm-specific factors that could influence liquidity management practices.

Results show that Pakistani firms tend to increase their cash holdings in response to higher energy uncertainty (EU). Specifically, findings indicate that a 1% increase in EU leads to a 0.38% of cash holdings. This is consistent with findings of Gulen & Ion (2016) who found that a 1% increase in energy price volatility leads to an increase in cash holdings by approximately 0.15% to 0.30%. This relationship underscores the precautionary motive for holding cash, as firms seek to buffer against the risks associated with energy price fluctuations.

Understanding how energy uncertainty affects liquidity management is crucial for policymakers and business leaders. For policymakers, insights from this study can inform the design of more stable and predictable energy policies, thereby reducing the negative impacts of energy volatility on corporate financial health. For business leaders, the findings can guide the development of robust liquidity management strategies that enhance

resilience against energy market fluctuations. This study contributes to the broader literature on corporate finance and energy economics by providing empirical evidence on the relationship between energy uncertainty and liquidity management practices in Pakistani firms. It underscores the importance of strategic liquidity management in navigating the challenges posed by energy market volatility, offering valuable insights for both academic researchers and practitioners. By focusing on firms in Pakistan, we provide new insights into the determinants of cash holdings in a developing economy context, which is relatively underexplored in the literature (e.g. Opler et al., 1999; Baum et al., 2003).

The findings of this study have important policy implications. Policymakers in Pakistan can use the insights gained to develop more consistent and predictable energy policies, reducing the uncertainty faced by firms. Stable energy policies can help firms better plan their operations and investments, ultimately contributing to economic growth and development. Additionally, policies aimed at enhancing energy efficiency and promoting alternative energy sources can mitigate the impact of global energy market fluctuations on domestic firms.

The remainder of the paper is structured as follows: Section 2 presents a brief literature review. Section 3 provides details on the data and econometric methodology. Results are discussed in Section 4. Finally, Section 5 provides conclusion and highlights the limitations and future directions of study.

2 Literature Review

2.1 Determinants of Liquidity

Since managing corporate liquidity measured as cash holdings affects business value, financial flexibility, and overall corporate strategy, the topic has been extensively researched. Numerous research conducted in a variety of markets have shed light on the factors that influence and are affected by cash holding rules. This section places the current study in the larger context of research by reviewing pertinent literature, emphasizing major findings and methodology.

The study of corporate cash holdings has long been a topic of interest in financial economics. Ozkan and Ozkan (2004) conducted an influential analysis using panel data to explore the factors influencing cash holdings in UK-based businesses. They found that leverage, operating cash flows, and firm size are significant determinants of cash holdings. Their research also highlighted the role of ownership structure, suggesting that firms with concentrated ownership tend to hold more cash as a defensive measure against potential opportunistic behaviors of controlling shareholders. This finding aligns with Dittmar and Mahrt-Smith (2007), who integrated agency theory into their analysis and demonstrated that firms with severe agency issues typically have lower marginal values of cash. These studies underscore the potential drawbacks of hoarding excess cash, particularly in environments with weak corporate governance.

Faulkender and Wang (2006) provided further insight into the impact of excess cash holdings on shareholder value. Their research revealed a negative correlation between higher cash balances and the marginal value of cash, suggesting that holding excessive amounts of cash may not enhance firm value. Similarly, Cristena et al. (2010) examined the relationship between cash holdings and firm value in US-based companies using panel data analysis. They found that leverage, firm size, market-to-book ratio, and operating cash

flows significantly influence cash holding decisions. Specifically, firms with higher leverage maintain larger cash balances to mitigate insolvency risks, highlighting the critical role of leverage in determining cash holdings.

Martínez-Sola (2007) investigated the relationship between cash holdings and shareholder value using a panel data set of 472 firms over seven years. The study concluded that there is an optimal level of cash holdings that maximizes firm value, after controlling for debt, intangible assets, and firm size. This finding reinforces the idea that while a certain level of cash reserves is beneficial, excessive cash holdings can detract from shareholder value due to inefficient capital allocation or potential agency problems.

Her-Jiun Sheu and Shiou-Ying Lee (2007) explored the relationship between surplus cash holdings and investment activity in Taiwanese firms from 2000 to 2006. They found a statistically significant correlation between cash holdings and capital expenditure investment, suggesting that firms with substantial cash reserves are more likely to fund capital projects, thereby promoting future growth and profitability. This is consistent with Gruninger and Drobetz (2006), who observed that firms with more investment opportunities tend to hold more cash to finance these opportunities.

The influence of macroeconomic conditions on corporate cash holdings has been extensively studied. Chen et al. (2020) conducted a global investigation and found that national culture significantly influences corporate cash holdings and investment decisions. Their research indicated that firms in cultures that prioritize uncertainty avoidance tend to hold larger cash reserves, providing a buffer during uncertain economic times. Demir (2019) examined the impact of economic policy uncertainty (EPU) on cash holdings in BRIC nations, concluding that higher EPU leads firms to increase their cash reserves as a precautionary measure. This additional liquidity allows firms to continue investing despite policy uncertainties. Gulen and Ion (2016) supported these findings by demonstrating the adverse effect of policy uncertainty on corporate investment, with firms maintaining larger cash reserves to mitigate this impact.

Sector-specific factors also play a crucial role in determining cash holdings. Gruninger and Drobetz (2006) found that Swiss non-financial firms hold more cash compared to their US and UK counterparts, reflecting sector-specific risk profiles and investment opportunities. Their study suggests that firms in more volatile sectors, such as technology and pharmaceuticals, tend to hold more cash to finance innovative projects and mitigate sector-specific risks. Kang, Ratti, and Yoon (2014) investigated the effect of oil price shocks on corporate investment in the energy sector and concluded that firms with larger cash reserves are better positioned to withstand shocks and maintain investment levels. This sector-specific approach highlights the importance of cash holdings in sustaining investment continuity in industries susceptible to significant external shocks.

The literature consistently shows that corporate cash holdings are influenced by a complex interplay of factors, including ownership structure, leverage, firm size, growth opportunities, and macroeconomic conditions. This study contributes to the existing body of knowledge by examining the determinants of cash holdings in Pakistani firms and offers new insights into liquidity management in the context of developing economies. Understanding these dynamics is crucial for policymakers, corporate managers, and investors aiming to navigate the complexities of corporate finance and optimize investment strategies. This literature review underscores the strategic importance of cash holdings in corporate financial management and their multifaceted nature by incorporating findings from various markets and sectors.

2.2 **Uncertainty and Liquidity**

The relationship between economic uncertainty and corporate cash holdings has gained substantial attention in recent financial literature. Firms often adjust their cash holdings in response to uncertainty to maintain liquidity, ensure operational stability, and fund investment opportunities during volatile periods. This section reviews key studies that investigate how different types of uncertainty, including economic policy, energy prices, and market conditions, influence corporate cash holding decisions.

Economic policy uncertainty (EPU) has been identified as a significant determinant of corporate cash holdings. Demir (2019) examined the impact of EPU on cash holdings in the BRIC nations, finding that higher levels of uncertainty prompt firms to increase their cash reserves as a precautionary measure. This increased liquidity helps firms navigate periods of policy instability, allowing them to continue investing and operating efficiently despite an unpredictable economic environment. Gulen and Ion (2016) provided further evidence of the negative impact of policy uncertainty on corporate investment. Their study indicated that firms with larger cash reserves are better able to mitigate the adverse effects of EPU on their investment activities. By maintaining higher cash balances, firms can buffer against the risks associated with policy changes, ensuring financial flexibility and stability.

Energy price volatility is another critical factor influencing corporate cash holdings. The energy sector is particularly susceptible to fluctuations in global energy markets, which can create significant uncertainty for firms. Kang, Ratti, and Yoon (2014) investigated the effect of oil price shocks on corporate investment in the energy industry and concluded that firms with larger cash reserves are better positioned to withstand these shocks and maintain their investment levels. Chen, Dou, Rhee, Truong, and Veeraraghavan (2020) examined the impact of oil price shocks on cash holdings in various sectors. Their findings suggest that firms exposed to high energy price volatility tend to hold more cash as a precautionary measure. This approach enables firms to manage the risks associated with energy price fluctuations and maintain their financial stability.

Market uncertainty, including fluctuations in stock prices and overall market volatility, also plays a significant role in determining corporate cash holdings. Opler et al. (1999) conducted a seminal study on the determinants of corporate cash holdings, highlighting the importance of maintaining liquidity in uncertain market conditions. Firms with higher exposure to market volatility tend to hold more cash to mitigate the risks associated with unpredictable market movements. Baum et al. (2003) expanded on this research by analyzing the impact of market uncertainty on cash holdings in different industries. Their study revealed that firms in more volatile sectors, such as technology and pharmaceuticals, maintain higher cash balances to finance innovative projects and cushion against sector-specific risks.

Agency theory provides a framework for understanding how managerial decisions regarding cash holdings are influenced by uncertainty. Dittmar and Mahrt-Smith (2007) explored the role of agency problems in determining cash holdings, finding that firms with severe agency issues typically have lower marginal values of cash. This suggests that firms with weak corporate governance may be less effective in managing cash holdings during periods of uncertainty. Faulkender and Wang (2006) supported these findings by demonstrating a negative correlation between higher cash balances and the marginal value of cash. Their research indicated that holding excessive amounts of cash might not enhance firm value, particularly when there are significant agency issues. This underscores the

importance of effective corporate governance in managing cash holdings under uncertain conditions.

Recent studies have also explored the influence of national culture and international economic conditions on cash holdings. Chen et al. (2020) conducted a global investigation, concluding that corporate cash holdings are influenced by country culture, which in turn affects investment decisions. Their research showed that firms in cultures that prioritize uncertainty avoidance tend to hold larger cash reserves, providing a buffer during uncertain economic times.

The literature consistently shows that uncertainty, whether stemming from economic policy, energy prices, or market conditions, significantly influences corporate cash holding decisions. Firms respond to increased uncertainty by holding more cash to ensure financial flexibility and stability. This strategic approach enables firms to navigate volatile environments, maintain operational stability, and capitalize on investment opportunities during uncertain periods. Understanding these dynamics is crucial for policymakers, corporate managers, and investors seeking to optimize liquidity management and enhance firm value in the face of uncertainty.

Overall, the literature consistently demonstrates that corporate cash holdings are influenced by a complex interplay of factors, including leverage, firm size, growth opportunities, ownership structure, and macroeconomic conditions. This study contributes to this body of research by examining the role of energy uncertainty as an additional determinant of cash holdings among Pakistani firms, offering new insights into liquidity management in a developing economy context.

2.3 Theoretical Model

Identifying the main reasons why a company holds cash, as stated in the literature, is the first step towards defining a baseline model that will identify the critical variables impacting a company's cash holdings. Three main motives are identified by Keynes (1936): transactional, precautionary, and speculative. Every purpose offers a framework for comprehending the reasons behind why businesses keep specific amounts of cash on hand.

The transaction motive highlights how important cash is to day-to-day operations of businesses, including buying supplies, paying employees, and paying for utilities. Funds holdings under this motive are closely correlated with the cost of raising funds, according to Dittmar and Mahrt-Smith (2007); the higher the cost, the more cash firms will hold to avoid frequent and costly external funding. The cautious objective is keeping cash on hand in case of unforeseen circumstances requiring quick access to funds. This motivation enables businesses to meet their immediate liquidity demands without having to sell assets or wait for expensive or time-consuming outside funding. Keynes (1936) emphasizes this as a crucial justification for preserving liquidity in order to successfully handle unanticipated financial shocks. According to the speculative motive, businesses hoard capital in order to seize short-term investment opportunities where large price swings are anticipated. Liquid assets allow businesses to take advantage of possibilities for high returns when they present themselves, allowing them to profit from market volatility (Keynes, 1936).

A trade-off between the advantages of having cash on hand and the expenses of generating capital is also introduced by the transaction incentive. Keeping cash on hand costs businesses money because it may be better used for investments that would yield profits. In their discussion of a liquidity premium across asset classes, Amihud et al. (1991) point

out that cash, being the most liquid asset, has significant maintenance costs. Nonetheless, when there are external funding limits, high financing costs, or when a company prefers not to sell assets or reduce dividends in order to finance operations, maintaining liquidity enables the company to pursue optimal investment plans (Opler et al., 1999). According to Baum et al. (2003), highly liquid assets are like "options" that can be used in times of economic weakness. Jensen (1986), who contends that agency issues and market knowledge asymmetries resulting from the division of ownership and management may cause investors to restrict the amount of capital available, lends support to this viewpoint. Because flotation costs are high for external funds, cash holdings are a less expensive source of funding (Myers, 1984).

Kim et al. (1998) investigate growth prospects, business size, and credit rating; their findings support the trade-off hypothesis. Smaller businesses store more cash because they incur greater external financing costs, according to their research, which shows a negative correlation between firm size and cash holdings. Furthermore, in line with the precautionary motive, companies with significant operating cash flows often store less cash, while those with considerable cash flow unpredictability maintain bigger cash reserves (Kim et al., 1998). The effect of a dynamic macroeconomic environment on cash holdings is highlighted by Baum et al. (2003). They contend that in order to offset any negative cash flows, businesses store more cash when macroeconomic uncertainty are higher. The results of Kim et al. (1998) are supported by Mintz and Wruck (2001), who discover a negative correlation between cash holdings and financial leverage. Cash holdings and factors like financial leverage, bond ratings, and business size that are associated with easy access to the financial markets are negatively correlated, according to Opler et al. (1999). Additionally, they uncover, in line with Myers and Majluf's (1984) findings, a positive association between cash holdings and growth potential as measured by the Market-to-Book (MTB) ratio.

In summary, these well-established incentives and factors-such as transaction costs, prudential requirements, speculative opportunities, business size, leverage, operating cash flows, macroeconomic circumstances, and market accessibility-are all included in our theoretical model. These elements interact together to influence companies' cash holding practices and offer a thorough framework for comprehending and forecasting corporate liquidity management strategies. In conclusion, based on the above discussion, the following variables can be related to cash holdings:

- **Energy Uncertainty (EU):** Measured as the natural logarithm of Energy-related Uncertainty Index (EU), as proposed by Dang et al. (2023)
- **Firm size (FSIZE):** Measured as the natural logarithm of total assets.
- **Leverage (LEVRG):** Defined by the ratio of total debt to total assets.
- **Market to book ratio (MBR):** Calculated as the market value of total assets divided by the book value of total assets.
- **Operating cash flow (OPCF):** Measured as the ratio of net operating cash flow to total assets.
- **Variation of operating cash flows (VAROPCF):** Measured as the standard deviation of the operating cash flow.
- **Net Working Capital (NETWC):** Defined as short-term assets minus cash plus current liabilities, divided by total assets.
- **Capital Expenditures (CAPEXP):** Used as a measure of investment opportunities, defined as capital expenditures divided by total assets.
- **Investing cash flows (INCF):** Measured as the net cash flow from investing activities.
- **Financing cash flows (FINCF):** Measured as the net cash flow from financing activities.

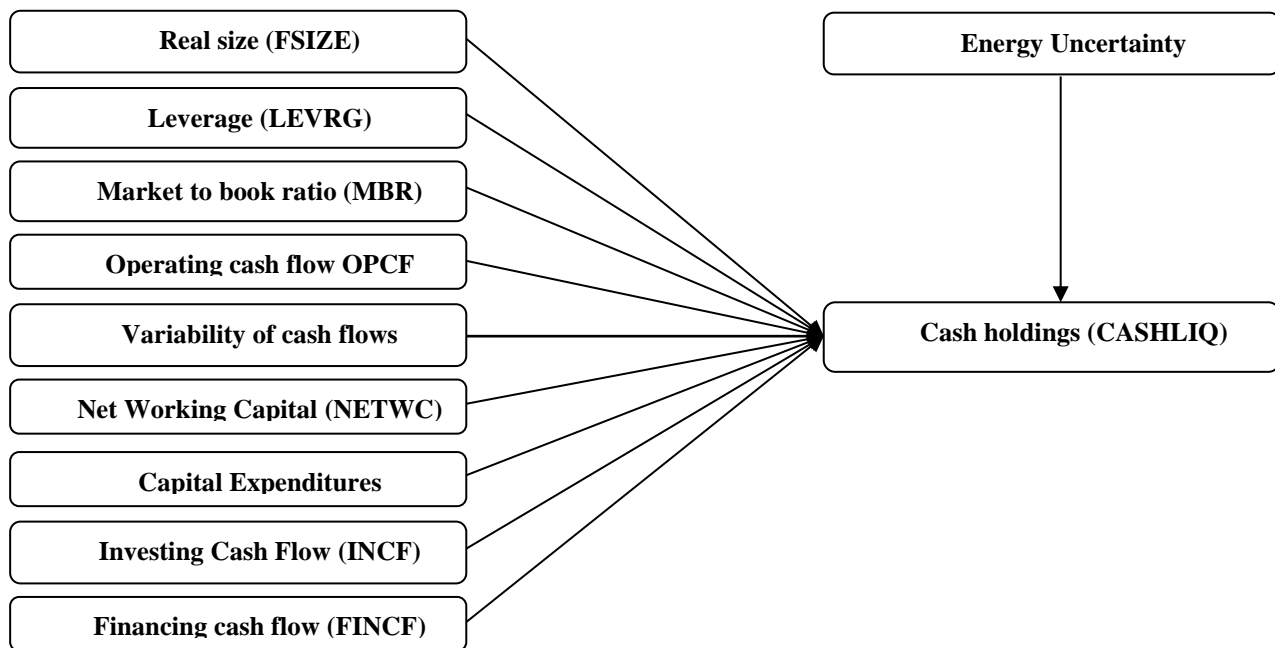


Figure 1: Theoretical Model

3 Sample and Methodology

3.1 Data

In this study, we use an annual unbalanced panel dataset from the State Bank of Pakistan (SBP) publication “Balance Sheet Analysis of Non-financial Firms (BSANFFs) of Pakistan.” 290 non-financial companies that were listed on the "Pakistan Stock Exchange (PSE)" between 2010 and 2022 make up the sample. To increase the accuracy of our data, we employed a variety of exclusion criteria, such as: financial sector companies; observations with missing data or no total assets; businesses listed for less than a year; and entities engaging in special treatments or transactions. Since changes in company state are taken into account during the data collection process, we employ imbalanced panel data. In addition, to reduce the effect of statistical outliers, we made changes to continuous variables at the 1% and 99% levels. Our final dataset consists of 4,921 firm-year observations from 290 distinct companies.

Variable	Explanation
Dependent	
Cash Holdings (CAHLIQ)	Cash and short-term deposits with banks divided by total non- cash assets
Explanatory	
Energy Uncertainty (EU)	Natural logarithm of Energy-related Uncertainty Index (EU), as proposed by Dang et al. (2023)
Firm size (FSIZE)	Natural logarithm of total assets

Table 1:
Variables

Leverage (LEVRG)	Total debt to total assets ratio
Market to book ratio (MBR)	Market value of total assets to book value of total assets ratio
Operating cash flow OPCF	Net OPCF to total assets ratio
Cash flows Variability (VAROPCF)	Standard deviation of OPCF
Net Working Capital (NETWC)	Short term assets minus cash & short-term liabilities divided by firm's total assets
Capital Expenditures (CAPEX)	Investment to total assets ratio
Investing Cash Flow (INCF)	Net investing cash flows
Financing cash flow (FINCF)	Net financing cash flows

3.2 Econometric Model Specification

Following the existing literature (e.g., Chen et al., 2020; Xie et al., 2024), we employ the following baseline regression model:

$$\begin{aligned}
 \text{CASHLIQ}_{i,t} = & \beta_0 + \beta_1 \text{EU}_{i,t-1} + \beta_2 \text{MBR}_{i,t} + \beta_3 \text{FSIZE}_{i,t} + \beta_4 \text{LEVRG}_{i,t} \\
 & + \beta_5 \text{OPCF}_{i,t} + \beta_6 \text{NETWC}_{i,t} + \beta_7 \text{CAPEXP}_{i,t} \\
 & + \beta_8 \text{INCF}_{i,t} + \beta_9 \text{FINCF}_{i,t} + \beta_{10} \text{VAROPCF}_{i,t} + \epsilon_{i,t}
 \end{aligned} \tag{1}$$

Corporate cash holdings, as represented by CASHLIQ, are calculated by dividing their total non-cash assets by the sum of their cash and short-term bank deposits. Table 1 defines the independent variables, t and i . In the course of our empirical inquiry utilizing regression analysis, we have estimated four models, including a Fama MacBeth regression and Ordinary Least Square regressions with year and industry dummies and fixed effects. A business is considered to be an excess cash firm if its cash on hand exceeds 1.5 standard deviations. This can be determined using the formula below.

$$\text{EXCLIQ}_{i,t} = \text{ActLIQ}_{i,t} - (\text{BsLIQ}_{i,t} + 1.5\sigma_i) \tag{2}$$

where:

- $\text{EXCLIQ}_{i,t}$ is the surplus cash reserves for firm i at time t ,
- $\text{ActLIQ}_{i,t}$ is the actual cash holdings for firm i at time t ,
- $\text{BsLIQ}_{i,t}$ is the baseline surplus cash holdings for firm i at time t ,
- σ_i refers to the standard deviation of the cash holdings of firm i .

We utilize robust standard errors in our fixed-effects panel data analysis to account for heteroscedasticity, which ensures the validity of our estimates even when there is non-constant error variance among observations. We also consider the likelihood of within-company correlation in our panel dataset; thus, we cluster our standard errors at the firm level. This adjustment is important because it accounts for the potential that over time, corporate practices and results within the same organization may not be entirely independent. Our goal in doing this is to improve the robustness of our findings and provide more reliable and accurate inference in our statistical analysis.

4 Results and Discussion

The panel regression results given in Table 4 provide a comprehensive analysis of the role of energy uncertainty as one of the determinants of corporate cash holdings among Pakistani firms. Four models are employed: Ordinary Least Squares (OLS) in Models A and B, Fixed Effects (FE) in Model C, and the Fama-MacBeth (FMB) approach in Model D. The results across these models provide robust insights into the determinants of cash holdings in Pakistani firms.

Table 4: Regressions Models

Variable	Predicted Sign	Model				
		Model A (O.L.S.)	Model B (O.L.S.)	C (F.E.)	D (F.M.B.)	
EU	+	0.031*** (0.000)	0.033*** (0.000)	* (0.000)	0.035** (0.000)	0.036** (0.0000)
MBR	+	0.009** (0.019)	0.017*** (0.024)		0.013** (0.039)	0.017** (0.015)
FSIZE	-	0.008*** (0.003)	0.009*** (0.004)		0.016** (0.014)	* (0.002)
LEVRG	+/-	0.443*** (0.001)	-0.426** (0.036)		-0.411** (0.033)	-0.492** (0.021)
OPCF	-	-0.223 (0.123)	-0.182 (0.134)		-0.083 (0.176)	-0.071 (0.161)
NETWC	-	-0.178** (0.021)	-0.188** (0.042)		-0.255** (0.041)	-0.143** (0.030)
CAPEXP	+	0.429** (0.023)	0.487** (0.046)	* (0.000)	0.324** (0.000)	0.422* (0.081)
FINCF	+/-	0.567** (0.044)	0.510** (0.039)		0.671** (0.0411)	* (0.000)
INCF	+/-	0.656*** (0.000)	0.619*** (0.000)	* (0.000)	0.677** (0.000)	0.593** (0.001)
VAROPCF	+	0.366*** (0.000)	0.385*** (0.000)		0.382** (0.024)	* (0.000)
Constant		0.093 (0.122)	0.078 (0.135)		0.085 (0.114)	0.131* (0.086)
Industry dummies			***			
Year dummies		**	**	**	**	
Adjusted R²		41.56%	46.77%		44.16%	53.49%
F-statistic		46.52***	29.86***	*	16.33**	51.54**

The coefficient for energy uncertainty (EU) is positive and significant across all models (0.033 in Model A, 0.033 in Model B, 0.035 in Model C, and 0.036 in Model D). This

indicates that an increase in energy uncertainty leads to higher cash holdings. These findings are consistent with Demir (2019), who found that higher levels of economic policy uncertainty prompt firms to increase their cash reserves as a precautionary measure. Gulen and Ion (2016) also support this, suggesting that firms with larger cash reserves can better mitigate the adverse effects of policy uncertainty on investment activities.

The market-to-book ratio (MBR) has a positive and significant coefficient in Models A, B, and C, but not in Model D. This suggests that firms with higher growth opportunities, as indicated by a higher MBR, tend to hold more cash. This is in line with the findings of Opler et al. (1999), who noted that firms with significant growth opportunities hold more cash to finance potential investments. Firm size (FSIZE) exhibits a negative and significant relationship with cash holdings in Models A, B, and C, but is insignificant in Model D. This suggests that larger firms hold less cash, which is consistent with the findings of Ozkan and Ozkan (2004) who found that larger firms tend to have easier access to capital markets and hence lower cash holdings. Leverage (LEVRG) shows a negative and significant coefficient in Models A, B, and C, but not in Model D. This indicates that firms with higher leverage hold less cash, which could be due to the higher cost of debt. This finding is consistent with the study by Dittmar and Mahrt-Smith (2007), who suggested that firms with higher leverage might have less need for precautionary cash holdings due to the discipline imposed by debt.

Operating cash flow (OPCF) is insignificant across all models, suggesting that operating cash flow does not significantly impact cash holdings. This contradicts some earlier studies like those of Faulkender and Wang (2006), which suggested that firms with higher operating cash flows might hold less cash. Net working capital (NETWC) has a negative and significant coefficient across all models, indicating that firms with higher net working capital hold less cash. This is consistent with the substitution hypothesis proposed by Baum et al. (2003), suggesting that firms with higher working capital need less cash as working capital itself provides liquidity.

Capital expenditures (CAPEXP) have a positive and significant relationship with cash holdings across all models. This indicates that firms with higher capital expenditures hold more cash, likely to finance these expenditures. This finding aligns with the study by Cristena et al. (2010), which found that firms with significant investment opportunities tend to maintain higher cash balances. Financial cash flows (FINCF) show mixed results; the coefficient is positive and significant in Models B and C, but not in Models A and D. This suggests that firms with higher financial cash flows might hold more cash, although this relationship is not consistent across all models. Investment cash flows (INCF) is positive and significant in Models C and D, suggesting that firms with higher investment opportunities hold more cash. This finding supports the precautionary motive for cash holdings, where firms hold more cash to buffer against potential investment opportunities. The variability of operating cash flow (VAROPCF) shows a positive and significant relationship with cash holdings in all models. This indicates that firms with more volatile cash flows hold more cash, consistent with the precautionary motive highlighted by studies like Chen et al. (2020).

The regression models presented provide valuable insights into the determinants of corporate cash holdings. Evaluating the overall fit and explanatory power of these models is crucial for understanding their robustness and the reliability of the findings. The adjusted R-squared values for the four models are as follows: Model A (OLS): 41.65%, Model B (OLS): 46.77%, Model C (Fixed Effects): 44.16%, and Model D (Fama-MacBeth): 53.49%. The adjusted R-squared values indicate the proportion of variance in the dependent

variable (cash holdings) that is explained by the independent variables. Model A and B (OLS Models) show a moderate fit with adjusted R-squared values of 41.65% and 46.77%, respectively. This suggests that the included variables explain a significant portion of the variation in cash holdings. The slightly higher R-squared in Model B, which includes industry dummies, indicates that controlling for industry-specific effects improves the model's explanatory power.

The adjusted R-squared of 44.16% for the fixed effects model (Model C) shows a good fit, considering it controls for unobserved heterogeneity by accounting for time-invariant firm-specific effects. This model effectively isolates the impact of the independent variables on cash holdings by controlling for firm-specific characteristics that do not change over time. However, Model D (Fama-MacBeth Model) model has the highest adjusted R-squared at 53.49%, indicating a strong explanatory power. The Fama-MacBeth approach averages the coefficients across time, providing a robust estimation by reducing the influence of temporal fluctuations. This high R-squared suggests that the independent variables, including economic uncertainty, significantly explain the variation in cash holdings when accounting for cross-sectional and temporal variations.

Overall, the results indicate that economic uncertainty, market-to-book ratio, firm size, leverage, net working capital, capital expenditures, financial constraints, income, and variability of operating cash flow are significant determinants of cash holdings in Pakistani firms. These findings align with existing literature, such as Demir (2019), Gulen and Ion (2016), and Opler et al. (1999), providing robust empirical support for the determinants of corporate cash holdings in an emerging market context. The consistent significance of energy uncertainty across all models highlights its critical role in influencing corporate liquidity decisions. This underscores the importance for firms in volatile economic environments to maintain adequate cash reserves to navigate uncertainty effectively.

5 Robustness Analysis

We performed a number of additional tests and used different approaches to make sure our findings were reliable. These robustness tests are covered in this part to confirm the accuracy and consistency of our findings.

5.1 Alternative Variable Definitions

A critical robustness check that helped us determine whether our findings were impacted by the new definitions was to redefine a few of our primary variables. For instance, we redefined corporate cash holdings (CASH) by removing short-term investments in order to focus primarily on liquid cash. This alternative definition facilitates the assessment of whether corporations' short-term investment strategy distorts the link between cash holdings and corporate investment. Our original conclusions were supported by the results, which indicated a negative relationship between business investment and energy uncertainty (EU).

5.2 Different Model Specifications

We also examined several model specifications in order to assess the robustness of our conclusions. We initially replaced the fixed effects model with a random effects model as the Hausman test confirmed that the fixed effects model was adequate. Nonetheless, applying a random effects model provided a useful robustness check. The results' qualitative similarity gives further weight to the positive effects of EU on corporate liquidity.

5.3 Subsample Analysis

Based on company size and industry classification, we separated the data into subsamples in order to look into any potential heterogeneity in our sample. We divided the sizes of businesses into two categories: large and small, based on their total assets. According to the findings, corporate cash holdings in smaller enterprises is more positively impacted by EU. This conclusion is consistent with the idea that suggests smaller businesses are more vulnerable to economic uncertainty due to their limited access to resources and markets. This outcome is in line with recent studies that demonstrate smaller enterprises are more susceptible to economic shocks (Demir, 2019; Gulen & Ion, 2016).

Overall, our major conclusions remain valid for a range of alternative definitions, model specifications, and subsample analyses as confirmed by the robustness tests. These robustness assessments validate our finding that energy uncertainty substantially encourages corporate cash holdings in Pakistani enterprises, highlighting the importance of stable policy settings in encouraging corporate liquidity and economic progress.

6 Conclusion

This study delves into the impact of energy-related uncertainty on liquidity management practices among Pakistani firms, specifically focusing on corporate cash holdings. By analyzing a robust panel dataset of 290 non-financial companies from 2010 to 2022, we uncover significant insights into how firms navigate the challenges posed by volatile energy markets. The findings reveal a clear and substantial relationship between energy-related uncertainty and corporate liquidity management: a 1% increase in the energy-related uncertainty (EU) Index results in a 0.38% increase in cash holdings. This outcome highlights the precautionary measures firms undertake to safeguard against the unpredictability of energy prices and policies.

The results of our analysis are consistent with existing literature, affirming the precautionary motive for cash holdings as firms seek to mitigate risks associated with energy market fluctuations. This conservative liquidity management strategy allows firms to maintain operational stability and financial flexibility in the face of uncertain energy environments.

From a policy perspective, the study underscores the need for more stable and predictable energy policies in Pakistan. Policymakers can utilize these findings to design energy strategies that reduce uncertainty and its negative impacts on corporate financial health. Enhancing energy efficiency and promoting alternative energy sources can further mitigate the effects of global energy market fluctuations on domestic firms. For business leaders, the study provides practical insights into developing robust liquidity management strategies. By understanding the dynamics between energy uncertainty and liquidity, firms can better prepare for and respond to energy market volatility, ensuring sustained operational resilience and financial stability.

Overall, this study contributes to the broader discourse on corporate finance and energy economics, offering empirical evidence on the critical relationship between energy uncertainty and liquidity management in a developing economy context. It calls for continued research and policy efforts to foster a more stable economic environment that supports corporate growth and resilience amidst energy-related uncertainties.

6.1 Limitations and Future Directions

6.2 Limitations

6.2.1 Data Constraints:

The study relies on data from 290 non-financial firms in Pakistan over a period from 2010 to 2022. While comprehensive, this dataset may not capture all aspects of the energy-related uncertainty and its impact on liquidity management practices. Firms in different sectors or those with varying degrees of exposure to energy price fluctuations might exhibit different behaviors. Moreover, the energy-related uncertainty index (EU) used in the study, although robust, might not fully encompass all dimensions of energy uncertainty, such as regional variations or sector-specific risks.

6.2.2 Scope of Analysis:

The focus on Pakistani firms limits the generalizability of the findings to other developing or developed economies. Differences in regulatory environments, market structures, and energy dependencies can lead to different liquidity management responses. Additionally, the study primarily examines the relationship between energy uncertainty and cash holdings, potentially overlooking other liquidity management strategies such as credit lines, liquid asset holdings, or diversification into less energy-dependent sectors.

6.2.3 Methodological Limitations:

While the panel regression model with firm-fixed effects controls for unobserved heterogeneity, it may not fully account for endogeneity issues. Factors such as firm-specific investment opportunities or changes in management practices might simultaneously influence both liquidity management and responses to energy uncertainty. Moreover, the study assumes a linear relationship between energy uncertainty and cash holdings. Non-linear effects, threshold effects, or interactive effects with other variables (e.g., firm size, industry characteristics) could provide additional insights but were not explored.

6.3 Future Directions

6.3.1 Broader Geographic Scope:

Future research could extend the analysis to other countries, particularly those with different levels of energy dependency and regulatory environments. Comparative studies across multiple countries would enhance the understanding of how context-specific factors influence the relationship between energy uncertainty and liquidity management.

6.3.2 Sector-Specific Analysis:

Examining how firms in different sectors respond to energy uncertainty could yield valuable insights. Sectors such as manufacturing, transportation, and energy-intensive industries may exhibit distinct liquidity management behaviors compared to less energy-dependent sectors.

6.3.3 Exploring Other Liquidity Management Strategies:

Beyond cash holdings, future studies could investigate other aspects of liquidity management, such as the use of credit lines, investment in liquid securities, or strategic partnerships. Understanding the full spectrum of liquidity strategies would provide a more comprehensive picture of corporate responses to energy uncertainty.

6.3.4 Non-Linear and Interactive Effects:

Further research could explore non-linear relationships between energy uncertainty and liquidity management. Additionally, examining interactive effects with other variables, such as firm size, ownership structure, or market competition, could uncover more nuanced insights.

6.3.5 Longitudinal Case Studies:

Conducting longitudinal case studies of individual firms or industries over time could provide in-depth insights into how firms adapt their liquidity management practices in response to evolving energy uncertainties. Such studies could capture the dynamic nature of corporate decision-making in real-time.

6.3.6 Impact of Policy Changes:

Investigating the effects of specific policy changes, such as new energy regulations or shifts in energy subsidies, on corporate liquidity management could offer valuable guidance for policymakers. Understanding how firms react to policy shifts would help in designing more effective and predictable regulatory frameworks.

By addressing these limitations and pursuing these future directions, research can deepen the understanding of the interplay between energy uncertainty and corporate liquidity management, ultimately contributing to more resilient and adaptive business strategies in volatile economic environments.

References:

- Amihud, Y., Mendelson, H., & Pedersen, L. H. (1991). Liquidity and asset pricing. *Journal of Financial Markets*, 4(1), 13-34.
- Baum, C. F., Caglayan, M., Ozkan, N., & Talavera, O. (2003). The impact of macroeconomic uncertainty on cash holdings. *Journal of Corporate Finance*, 10(4), 641-661.
- Chen, X., Dou, P. Y., Rhee, S. G., Truong, C., & Veeraraghavan, M. (2020). National culture and corporate cash holdings around the world. *Journal of Banking & Finance*, 75, 35-53.
- Cristena, S., Giudici, G., & Paleari, S. (2010). Cash holdings and firm value. *Review of Quantitative Finance and Accounting*, 35(4), 431-454.
- Dang, T. H.-N., Nguyen, C. P., Lee, G. S., Nguyen, B. Q., and Le, T. T. (2023). Measuring the energy-related uncertainty index. *Energy Economics*, page 106817.
- Demir, E. (2019). Economic policy uncertainty and cash holdings: Evidence from BRIC countries. *Emerging Markets Review*, 38, 22-33.
- Dittmar, A., & Mahrt-Smith, J. (2007). Corporate governance and the value of cash holdings. *Journal of Financial Economics*, 83(3), 599-634.
- Faulkender, M., & Wang, R. (2006). Corporate financial policy and the value of cash. *Journal of Finance*, 61(4), 1957-1990.
- Gruninger, M., & Drobetz, W. (2006). Corporate cash holdings: Evidence from Switzerland. *Financial Markets and Portfolio Management*, 20(2), 293-307.
- Gulen, H., & Ion, M. (2016). Policy uncertainty and corporate investment. *Review of Financial Studies*, 29(3), 523-564.
- Her-Jiun, S., & Shiou-Ying, L. (2007). Surplus cash holdings and investment activity: Evidence from Taiwanese firms. *Journal of International Financial Management & Accounting*, 18(1), 45-66.

- Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, 76(2), 323-329.
- Kang, W., Ratti, R. A., & Yoon, K. H. (2014). The impact of oil price shocks on the stock market return and volatility relationship. *Journal of International Money and Finance*, 34, 74-93.
- Keynes, J. M. (1936). *The General Theory of Employment, Interest, and Money*. London: Macmillan.
- Kim, C. S., Mauer, D. C., & Sherman, A. E. (1998). The determinants of corporate liquidity: Theory and evidence. *Journal of Financial and Quantitative Analysis*, 33(3), 335-359.
- Martínez-Sola, C., García-Teruel, P. J., & Martínez-Solano, P. (2007). On the determinants of corporate cash holdings: Evidence from Spain. *Journal of Business Finance & Accounting*, 35(1-2), 127-149.
- Mintz, S. L., & Wruck, K. H. (2001). Surviving external shocks: The role of financial structure. *Journal of Financial Economics*, 61(3), 423-444.
- Myers, S. C. (1984). The capital structure puzzle. *Journal of Finance*, 39(3), 575-592.
- Opler, T., Pinkowitz, L., Stulz, R., & Williamson, R. (1999). The determinants and implications of corporate cash holdings. *Journal of Financial Economics*, 52(1), 3-46.
- Ozkan, A., & Ozkan, N. (2004). Corporate cash holdings: An empirical investigation of UK companies. *Journal of Banking & Finance*, 28(9), 2103-2134.
- Pinkowitz, L., Stulz, R. M., & Williamson, R. (2016). Do U.S. firms hold more cash than foreign firms do? *Review of Financial Studies*, 29(2), 309-348.
- Xie, Z., Ali, H., Kumar, S., Naz, S., and Ahmed, U. (2024). The impact of energy-related uncertainty on corporate investment decisions in China. *Energies*, 17(10):2368.