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Climate Policy Uncertainty and Corporate Cash Holdings: Evidence from Listed Non-Financial Firms in Pakistan

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ABSTRACT

This study investigates the effect of climate policy uncertainty on corporate cash holdings among listed non-financial firms in Pakistan over the period 2010–2024. Drawing on the trade-off theory, pecking-order theory, and the precautionary motive of cash holdings, the study argues that firms are likely to retain more liquidity when climate-related policy conditions become more uncertain. Using panel-data techniques, the analysis estimates a baseline fixed-effects model with firm-clustered robust standard errors and supplements it with a dynamic system GMM specification as a robustness and endogeneity check. An interaction-based specification is also estimated to explore whether leverage conditions the relationship between climate policy uncertainty and cash holdings. The baseline results show that climate policy uncertainty has a positive and statistically significant effect on corporate cash holdings, indicating that firms increase precautionary liquidity buffers in response to climate-policy risk. This core finding remains robust in the dynamic system GMM model, where climate policy uncertainty continues to exhibit a positive and significant coefficient. However, the dynamic specification does not provide evidence of significant cash-holding persistence, and the interaction model shows that leverage does not significantly moderate the climate policy uncertainty–cash holdings relationship. Overall, the study contributes to the growing intersection of corporate finance and climate finance by showing that climate-policy uncertainty is a meaningful determinant of corporate liquidity policy in an emerging-market context. The findings imply that firms treat climate-policy instability as a financially relevant source of risk and respond by strengthening internal liquidity positions to preserve flexibility under uncertainty.



Introduction

Corporate cash holdings remain a central issue in corporate finance because cash provides firms with transactional convenience, precautionary insurance, and strategic flexibility, while also creating potential agency concerns when managers retain excessive liquidity. Foundational evidence shows that firms with stronger growth opportunities, riskier cash flows, and more limited access to external finance tend to hold larger cash balances, consistent with the trade-off view of liquidity management (Opler et al., 1999). Later work shows that corporate cash ratios increased substantially over time, reflecting shifts in firm risk, investment structure, and the growing value of internal liquidity (Bates et al., 2009). More recent evidence continues to confirm that cash policy is an active balance-sheet decision shaped by risk conditions, financing frictions, and institutional settings rather than a passive accounting residue (Caixe et al., 2025; Yang et al., 2024).

A major extension of this literature concerns the role of uncertainty. When firms operate in uncertain policy environments, the value of internal liquidity generally rises because managers may face tighter financing conditions, delayed investment opportunities, and more volatile operating cash flows. Consistent with this precautionary channel, Demir and Ersan (2017) find that economic policy uncertainty is associated with higher cash holdings among firms in BRIC countries, while Heeney et al. (2023) and Yang et al. (2024) likewise report positive associations between uncertainty and corporate liquidity retention. However, the broader evidence is not fully uniform. International studies show that the effect of uncertainty on cash holdings may depend on institutional quality, governance structures, and firm-level financial conditions, implying that the uncertainty–cash nexus is context specific rather than universal (Javadi et al., 2021; Caixe et al., 2025).

Within this broader uncertainty literature, climate policy uncertainty has emerged as an increasingly important but still underexplored dimension of corporate-finance research. Climate policy uncertainty refers to uncertainty surrounding carbon regulation, emissions standards, transition rules, environmental compliance requirements, and other climate-related government actions that shape firms' expected costs, risks, and financing conditions. Recent evidence shows that climate policy uncertainty affects important corporate outcomes. For example, Zhao et al. (2025) show that rising climate policy uncertainty reduces corporate investment, while Zhang and Gao (2024) report that climate policy uncertainty is negatively associated with corporate cash holdings in the U.S. tourism and hospitality sector. Related recent evidence also suggests that climate-related risk can alter firms' liquidity behavior by heightening operational uncertainty and changing investment incentives (Ruan et al., 2025). These findings indicate that climate-policy risk is no longer peripheral to corporate finance; it can shape core financial decisions at the firm level.

Despite this growing literature, direct evidence on the relationship between climate policy uncertainty and corporate cash holdings remains limited and mixed. This gap is especially important in emerging markets, where firms often face tighter financing constraints, more volatile macroeconomic conditions, and less predictable regulatory environments than firms in advanced economies. Pakistan provides a relevant setting for examining this issue. The Pakistan Climate Policy Uncertainty Index, developed by Syed et al. (2024), offers a country-specific measure of climate-related policy uncertainty, while the Pakistan Stock Exchange provides access points for listed-company financial reports and corporate financial information. These developments create a timely opportunity to investigate whether climate-policy uncertainty affects the liquidity decisions of listed non-financial firms in Pakistan.

This study examines the effect of climate policy uncertainty on corporate cash holdings among listed non-financial firms in Pakistan. The study is grounded primarily in the trade-off theory, pecking-order theory, and precautionary motive of cash holdings. The central expectation is that climate policy uncertainty increases the value of internal liquidity because firms may seek to hedge against future compliance costs, transition-related obligations, financing frictions, and delayed investment opportunities. In addition to the baseline fixed-effects model, the study estimates a dynamic system GMM specification as a robustness and endogeneity check, and it further explores whether leverage conditions firms' liquidity response to climate policy uncertainty through an interaction-based extension. This design allows the paper to assess not only the main direct effect of climate policy uncertainty on cash holdings, but also whether that effect remains stable under alternative econometric treatments.

The study contributes to the literature in three main ways. First, it extends the corporate cash-holdings literature by focusing specifically on climate policy uncertainty rather than broader economic policy uncertainty. Second, it provides new evidence from Pakistan, an underexplored but highly relevant emerging-market setting where climate risk and policy uncertainty are both salient. Third, it complements the baseline fixed-effects evidence with a dynamic panel GMM robustness check and an exploratory leverage-conditioned specification, thereby providing a broader empirical assessment of the uncertainty–cash relationship. In doing so, the study contributes to the growing intersection of corporate finance and climate finance by showing how climate-policy uncertainty can influence one of the most fundamental balance-sheet decisions: how much cash firms choose to hold.

Literature Review

Corporate cash holdings have long occupied a central place in corporate finance because they reflect firms' responses to liquidity needs, financing frictions, investment opportunities, and governance considerations. Rather than constituting a passive residual of firm operations, cash balances are increasingly viewed as a strategic component of financial policy that enables firms to manage uncertainty, preserve flexibility, and sustain value under changing market conditions. As a result, the literature on cash holdings has evolved from early firm-level explanations of liquidity demand to broader analyses that connect cash policy to macroeconomic, institutional, and policy-related shocks. In this study, the relevant literature can be organized into four closely related strands: the traditional corporate cash-holdings literature, the uncertainty–cash holdings literature, the emerging literature on climate policy uncertainty, and the literature on dynamic cash adjustment. Together, these strands provide the theoretical and empirical foundation for examining whether climate policy uncertainty influences corporate cash holdings among listed non-financial firms in Pakistan.

The starting point of this discussion is the classical literature on why firms hold cash. Opler et al. (1999) provide one of the most influential empirical analyses in this area, showing that firms with stronger growth opportunities and riskier cash flows tend to hold more cash, whereas firms with easier access to capital markets tend to hold less. Their findings support the trade-off view, according to which firms determine cash balances by weighing the benefits of liquidity against its opportunity costs. Bates et al. (2009) extend this line of inquiry by showing that U.S. firms' cash ratios increased substantially over time because cash flows became riskier and firms became less reliant on inventories and receivables. Taken together, these studies establish that corporate cash holdings are a deliberate financial-policy choice shaped by firm risk, financing frictions, and balance-sheet structure rather than a passive accounting outcome.

From a theoretical perspective, the literature commonly explains corporate cash holdings through the trade-off theory, the pecking-order theory, and agency theory. Under the trade-off view, firms maintain an optimal level of cash by balancing the liquidity benefits of cash against the costs of holding low-yielding assets. Under the pecking-order view, firms prefer internal finance to external capital because of information asymmetry and issuance costs, implying that firms may accumulate cash to reduce future dependence on outside financing. Agency theory, by contrast, suggests that managers may retain excessive cash when monitoring is weak, thereby increasing the possibility that liquidity reflects discretion rather than efficiency. These theoretical perspectives are important because they imply that firms' cash-holding behavior may respond differently to uncertainty. While precautionary and financing-friction channels predict higher cash retention, agency-related concerns may weaken or even reverse that response. For this reason, the effect of uncertainty on corporate cash holdings has been treated in the empirical literature as an open and context-dependent question rather than a uniform prediction.

A substantial body of empirical work has examined whether uncertainty affects firms' cash-retention behavior. Demir et al. (2017), using BRIC firms, find that economic policy uncertainty increases corporate cash holdings after controlling for firm characteristics and year effects. Related evidence also shows that uncertainty itself, and even the volatility of uncertainty, can increase firms' incentives to retain cash as a precautionary buffer. Goodell et al. (2021), for example, report that greater volatility of economic policy uncertainty is associated with higher corporate cash holdings. Phan et al. (2019) similarly document a positive relationship between policy uncertainty and cash holdings, especially for firms that are more exposed to government spending channels. These findings broadly support the precautionary liquidity argument that uncertainty increases the value of internal funds.

However, the broader uncertainty cash literature is not entirely one-directional. Some studies show that the sign and strength of the relationship depend on governance conditions, institutional quality, and firm-level financial characteristics. More recent work continues to document that uncertainty affects cash holdings differently across settings and ownership structures, indicating that country context and firm heterogeneity remain important. This suggests that the uncertainty cash nexus should be tested in specific institutional environments rather than assumed to be universal.

The more recent literature on climate policy uncertainty sharpens this inquiry by focusing specifically on uncertainty over climate-related regulation, transition rules, emissions standards, and compliance requirements. Climate policy uncertainty differs from broader economic policy uncertainty because it is tied directly to environmental transition risk and the regulatory architecture of decarbonization. Recent evidence shows that climate policy uncertainty affects real corporate behavior. For instance, work on U.S. tourism and hospitality firms finds that climate policy uncertainty is significantly negatively associated with capital investment. Other studies report that climate policy uncertainty reduces corporate investment more broadly, indicating that firms delay or scale back investment when the climate-policy environment becomes less predictable. These findings suggest that climate policy uncertainty is increasingly relevant to mainstream corporate-finance outcomes. Despite this growing literature, direct evidence on climate policy uncertainty and corporate cash holdings remains limited and mixed. Zhang and Gao (2024) provide one of the clearest studies in this area, showing that climate policy uncertainty is negatively associated with corporate cash holdings among U.S. tourism and hospitality firms, and that the effect persists for about two years before fading. This is important because it suggests that climate-specific uncertainty may not always produce the same positive cash response observed under broader economic policy uncertainty. Instead, the sign of the effect may depend on sectoral exposure, country setting, and the financing environment in which firms operate. That unresolved

pattern leaves room for additional country-specific evidence. Another important strand concerns the dynamic nature of corporate cash holdings.

The literature increasingly recognizes that firms do not reset cash balances from scratch each year. Instead, they adjust gradually toward target liquidity levels because of adjustment costs, financing frictions, and internal planning constraints. Research on cash-adjustment speed shows that firms actively move toward target cash positions, but the speed of that adjustment varies across firms and institutional settings. This literature provides the rationale for including lagged cash holdings in empirical analysis and for using dynamic panel methods as a robustness approach when studying liquidity policy. Further issue is whether firms' financial structure conditions their response to uncertainty. The uncertainty literature increasingly emphasizes that heterogeneity matters. Highly leveraged firms, for example, may be more financially exposed under uncertain policy conditions because they face greater refinancing pressure and debt-servicing obligations. In such cases, uncertainty may increase the precautionary value of cash more strongly for firms with weaker balance-sheet flexibility. This does not guarantee a significant moderating role for leverage in every setting, but it does provide a theoretically plausible basis for testing whether firms with different debt exposure respond differently to climate policy uncertainty. Overall, the literature points to three broad conclusions. First, corporate cash holdings are a deliberate and theoretically rich financial-policy choice shaped by liquidity needs, financing frictions, and agency considerations. Second, uncertainty generally matters for cash policy, but the direction and magnitude of the effect vary across contexts. Third, climate policy uncertainty is an increasingly important but still underexplored source of corporate-finance risk, especially with respect to cash holdings in emerging markets. These gaps are particularly relevant for Pakistan, where the availability of a country-specific climate policy uncertainty index now makes such analysis empirically feasible.

Although the literature on corporate cash holdings is extensive, three gaps remain. First, most studies on uncertainty and cash holdings focus on general economic policy uncertainty rather than climate policy uncertainty. Second, the limited climate-specific literature has produced mixed results and remains concentrated outside Pakistan. Third, while dynamic cash adjustment and firm heterogeneity are relevant in the broader cash-holdings literature, they have rarely been integrated into climate-policy uncertainty research in an emerging-market setting. The availability of the Pakistan climate policy uncertainty index creates an opportunity to address these gaps directly.

The primary theoretical expectation of this study is grounded in the precautionary motive and the pecking-order view of corporate cash holdings. When climate policy uncertainty rises, firms face greater uncertainty regarding future compliance costs, transition-related obligations, financing conditions, and investment timing. Under such conditions, firms are expected to strengthen internal liquidity in order to preserve financial flexibility and reduce reliance on costly or uncertain external finance. This leads to the study's main hypothesis:

H1: Climate policy uncertainty has a positive and significant effect on corporate cash holdings among listed non-financial firms in Pakistan.

In addition to the direct effect, the literature on cash adjustment suggests that corporate liquidity policy may exhibit persistence over time. Firms do not always adjust cash balances instantaneously; instead, they may move gradually toward desired liquidity levels because of adjustment costs, planning constraints, and financing frictions. This motivates a supplementary dynamic hypothesis:

H2: Corporate cash holdings are dynamically persistent, such that lagged cash holdings have a positive and significant effect on current cash holdings.

A further issue concerns whether firms' financial structure influences how they respond to uncertainty. In particular, highly leveraged firms may be more financially vulnerable under uncertain policy conditions because they face stronger refinancing pressure and debt-servicing obligations. This raises the possibility that leverage may condition the relationship between climate policy uncertainty and corporate cash holdings. Since the direction and strength of this effect remain an empirical question, the study treats it as an extension rather than a core theoretical prediction:

H3: Leverage moderates the relationship between climate policy uncertainty and corporate cash holdings.

Conceptual Framework

The conceptual framework of the study reflects these relationships. Climate policy uncertainty is modelled as the main explanatory variable affecting corporate cash holdings. Lagged cash holdings capture the possible dynamic dimension of liquidity policy, while leverage is incorporated as an extension variable to assess whether the main relationship varies across firms with different debt exposure. Standard firm-level controls profitability, tangibility, current ratio, sales growth, operating cash flow, and net working capital ratio—are included to account for other determinants of liquidity policy.

Figure 1. Conceptual framework

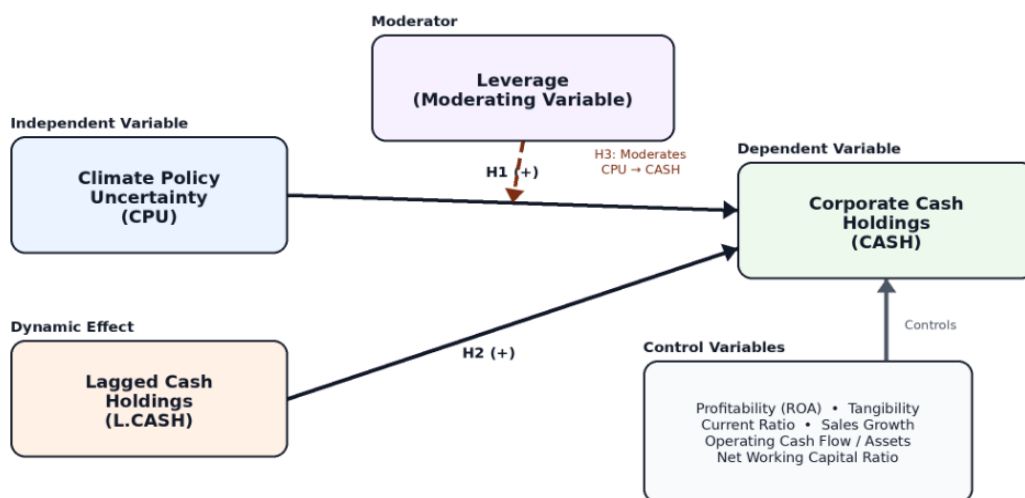


Figure 1 illustrates the direct effect of climate policy uncertainty on corporate cash holdings, the supplementary dynamic role of lagged cash holdings, and the exploratory moderating role of leverage.

Methodology

Research Design

This study employs a quantitative panel-data design to examine the relationship between climate policy uncertainty and corporate cash holdings among listed non-financial firms in Pakistan. A panel framework is appropriate because it combines cross-sectional variation across firms with time-series variation within firms, allowing the analysis to control for unobserved firm-specific

characteristics that may influence liquidity policy. In the corporate cash-holdings literature, such firm-specific effects are important because liquidity decisions are shaped not only by observable financial variables but also by persistent factors such as management style, risk culture, and ownership structure (Opler et al., 1999; Bates et al., 2009).

The empirical strategy is structured in three stages. First, the study estimates a baseline fixed-effects model to identify the direct effect of climate policy uncertainty on cash holdings. Second, it estimates a dynamic panel model as a robustness and endogeneity check because prior research shows that cash-holding behavior may adjust gradually over time rather than instantaneously (Jiang & Lie, 2016; Orlova & Rao, 2018). Third, it estimates an interaction model to explore whether leverage conditions the effect of climate policy uncertainty on corporate cash holdings. This structure allows the analysis to distinguish the core direct effect from supplementary dynamic and heterogeneity tests.

Data Sources and Sample

Firm-level financial data are drawn from the Pakistan Stock Exchange (PSX), specifically from its listed-company financial-report resources. These PSX resources provide the annual financial statements and company-level accounting information needed to construct the panel variables used in the analysis. The key explanatory variable, climate policy uncertainty, is obtained from the Pakistan Climate Policy Uncertainty Index published by PolicyUncertainty.com, which states that the Pakistan CPU index was constructed by Syed, Mohsin, and Saleh (2024) following the Baker, Bloom, and Davis framework. The study focuses on listed non-financial firms over the period 2010–2024. Financial institutions such as banks, insurance companies, leasing firms, and other regulated financial entities are excluded because their liquidity management, balance-sheet structure, and regulatory requirements differ fundamentally from those of non-financial firms. This exclusion is standard in the corporate cash-holdings literature and is consistent with the empirical designs used in foundational studies such as Opler et al. (1999) and Bates et al. (2009).

Variable Measurement

The dependent variable in this study is corporate cash holdings (CASH), measured as the ratio of cash and cash equivalents to total assets. This measure is standard in the empirical cash-holdings literature and has been widely adopted in prior studies because it captures the proportion of firm resources maintained in liquid form. The main explanatory variable is climate policy uncertainty (CPU). Since the Pakistan CPU index is available at a higher frequency, it is transformed into an annual average to ensure consistency with the annual firm-level financial statements used in the analysis. This annualized measure captures the average level of climate-related policy uncertainty faced by firms in each year. PolicyUncertainty.com identifies the Pakistan CPU index as a country-specific climate policy uncertainty series. Consistent with the standard cash-holdings literature, the study also includes a set of firm-level control variables, namely leverage, profitability, tangibility, current ratio, sales growth, operating cash flow to assets, and net working capital ratio. These variables are commonly employed because they reflect firms' financing structure, earnings performance, collateralizable asset base, short-term liquidity position, growth opportunities, internal liquidity generation, and working-capital substitutes for cash (Opler et al., 1999; Ozkan & Ozkan, 2004).

Table 1. Variable Measurement

Variable	Symbol	Measurement	Role	Expected Sign
Corporate cash holdings	CASH	Cash and cash equivalents / total assets	Dependent variable	—
Climate policy uncertainty	CPU	Annual average Pakistan climate policy uncertainty index	Main independent variable	+
Lagged cash holdings	L.CASH	One-period lag of cash holdings	Dynamic regressor	+
Leverage	LEV	Total liabilities / total assets	Control / interaction variable	±
Profitability	ROA	Net income / total assets	Control	±
Tangibility	TANG	Property, plant and equipment / total assets	Control	—
Current ratio	CR	Current assets / current liabilities	Control	±
Sales growth	SG	(Sales _t - Sales _{t-1}) / Sales _{t-1}	Control	+
Operating cash flow / assets	OCF	Operating cash flow / total assets	Control	±
Net working capital ratio	NWC	(Current assets – current liabilities) / total assets	Control	—
Year effects	λ_t	Year dummy variables	Common macro and policy shocks	—
Firm effect	μ_i	Time-invariant unobserved firm-specific effect	Unobserved heterogeneity	—

Model Specification

Baseline Model

To estimate the direct effect of climate policy uncertainty on corporate cash holdings, the study specifies the following baseline model:

$$CASH_{it} = \alpha + \beta_1 CPU_t + \beta_2 LEV_{it} + \beta_3 ROA_{it} + \beta_4 TANG_{it} + \beta_5 CR_{it} + \beta_6 SG_{it} + \beta_7 OCF_{it} + \beta_8 NWC_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where $CASH_{it}$ is corporate cash holdings of firm i in year t ; CPU_t is climate policy uncertainty in year t ; LEV_{it} , ROA_{it} , $TANG_{it}$, CR_{it} , SG_{it} , OCF_{it} , and NWC_{it} are firm-level control variables; μ_i captures unobserved firm-specific effects; λ_t captures year effects; and ε_{it} is the idiosyncratic error term. The coefficient of primary interest is β_1 , which is expected to be positive.

Dynamic Model

Because prior research suggests that firms may adjust cash balances gradually toward target levels, the study also estimates a dynamic model:

$$CASH_{it} = \alpha + \rho CASH_{it-1} + \beta_1 CPU_t + \beta_2 LEV_{it} + \beta_3 ROA_{it} + \beta_4 TANG_{it} + \beta_5 CR_{it} + \beta_6 SG_{it} + \beta_7 OCF_{it} + \beta_8 NWC_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Here, ρ captures the persistence of corporate cash holdings. Since including a lagged dependent variable in a fixed-effects setting may create dynamic panel bias, this specification is estimated using two-step system GMM as a robustness and endogeneity check.

Interaction Model

To explore whether leverage conditions the effect of climate policy uncertainty on cash holdings, the study estimates the following interaction model:

$$CASH_{it} = \alpha + \beta_1 CPU_t + \beta_2 LEV_{it} + \beta_3 (CPU_t \times LEV_{it}) + \beta_4 ROA_{it} + \beta_5 TANG_{it} + \beta_6 CR_{it} + \beta_7 SG_{it} + \beta_8 OCF_{it} + \beta_9 NWC_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

The interaction term $(CPU_t \times LEV_{it})$ tests whether the climate policy uncertainty–cash holdings relationship varies across firms with different leverage levels. In this study, this model is treated as an exploratory extension.

Estimation Technique

The empirical analysis begins with the estimation of both fixed-effects (FE) and random-effects (RE) models. The fixed-effects estimator is appropriate when unobserved firm-specific characteristics are correlated with the explanatory variables, whereas the random-effects estimator assumes that such unobserved effects are not correlated with the regressors. To determine the more appropriate estimator, the study employs the Hausman specification test. Where the Hausman test rejects the null hypothesis of no systematic difference between FE and RE estimates, the fixed-effects model is retained as the preferred specification.

Because heteroskedasticity is common in firm-level panel data, the study reports firm-clustered robust standard errors in the preferred fixed-effects model. This approach corrects the standard errors for heteroskedasticity and possible within-firm serial dependence, thereby improving the reliability of statistical inference.

In addition to the baseline panel estimators, the study estimates a two-step system GMM model as a robustness and endogeneity check. This dynamic specification is particularly useful because it accommodates the inclusion of lagged cash holdings while helping to address potential endogeneity, unobserved heterogeneity, and dynamic panel bias. The validity of the system GMM specification is assessed using the instrument count, the Arellano–Bond tests for serial correlation, and the Hansen test of overidentifying restrictions. In general, a valid GMM model is expected to show an insignificant AR(2) statistic and an insignificant Hansen test, indicating the absence of second-order serial correlation and the validity of the instruments.

Diagnostic and Robustness Tests

Several diagnostic procedures are employed to ensure the reliability of the estimates.

- First, the Hausman test is used to select between fixed and random effects.
- Second, the Modified Wald test for groupwise heteroskedasticity is used after the fixed-effects model to assess whether error variances differ across firms.

- Third, the variance inflation factor (VIF) is used to evaluate multicollinearity among the explanatory variables. A mean VIF substantially below 10 suggests that multicollinearity is not severe.
- Fourth, the system GMM diagnostics specifically AR(1), AR(2), Sargan, and Hansen tests are used to evaluate the validity of the dynamic specification.

These procedures collectively ensure that the preferred model is supported not only by theory but also by econometric diagnostics.

A Priori Expectations

Based on the precautionary motive and financing-friction logic, the study expects the coefficient on climate policy uncertainty to be positive:

$$\beta_1 > 0$$

The dynamic coefficient on lagged cash holdings is expected to be positive if cash holdings are persistent over time:

$$\rho > 0$$

The sign of the interaction term between climate policy uncertainty and leverage is treated as an empirical question, though a positive value would indicate that more highly leveraged firms retain more cash when climate policy uncertainty rises.

Methodology Summary

In summary, the study uses a panel framework to estimate the effect of climate policy uncertainty on corporate cash holdings among listed non-financial firms in Pakistan. The main model is a fixed-effects specification with firm-clustered robust standard errors. To strengthen the analysis, the study also estimates a dynamic system GMM model as a robustness and endogeneity check and an interaction model to explore whether leverage conditions the main relationship. This structure ensures that the paper addresses the core direct effect while also testing whether the result remains robust under alternative econometric treatments and firm financial conditions.

Results and Discussion

Descriptive Statistics

Table 2 reports the descriptive statistics. The mean value of cash holdings is 0.110, indicating that firms hold about 11.0% of total assets in cash and cash equivalents on average. This suggests that liquidity reserves constitute a meaningful component of firm asset structure. The standard deviation of 0.034 indicates moderate variation across firms and over time.

The mean value of climate policy uncertainty is 114.246, with a standard deviation of 10.426, indicating substantial year-to-year fluctuation in the climate-policy environment. This variation is useful for identification because it implies that firms are exposed to meaningfully changing policy uncertainty across the sample period.

Among the controls, average leverage is 0.482, implying that liabilities account for nearly half of total assets. Profitability (ROA) averages 0.017, indicating modest returns, while tangibility averages 0.339, showing that fixed assets account for roughly one-third of total assets. The mean current ratio is 1.331, suggesting that firms generally maintain current assets above current liabilities. Sales growth averages 0.062, although with substantial dispersion. Operating cash flow

to assets averages 0.036, while net working capital ratio averages 0.088. Overall, the variables exhibit sufficient dispersion to support panel estimation.

Table 2. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Cash holdings	1,800	0.10997	0.03380	0.00469	0.21586
Climate policy uncertainty	1,800	114.24600	10.42558	98.79000	129.84000
Leverage	1,800	0.48209	0.12873	0.06501	0.87085
Profitability (ROA)	1,800	0.01717	0.02964	-0.08287	0.15113
Tangibility	1,800	0.33906	0.10672	0.04755	0.76745
Current ratio	1,800	1.33066	0.36768	0.62065	3.29712
Sales growth	1,680	0.06219	0.41969	-0.78670	2.58172
Operating cash flow / assets	1,800	0.03608	0.03808	-0.08308	0.18336
Net working capital ratio	1,800	0.08828	0.10841	-0.25283	0.35246

Note: Sales growth has fewer observations because it is computed using lagged sales.

Correlation Matrix

Table 3 presents the Pearson correlation matrix. The correlation between climate policy uncertainty and cash holdings is positive, offering preliminary support for the main hypothesis that firms retain more cash when climate-policy uncertainty rises. The correlations among the explanatory variables are generally modest to moderate.

The strongest relationship appears between current ratio and net working capital ratio, which is expected because both capture dimensions of short-term liquidity. Similarly, profitability and operating cash flow to assets are positively correlated, reflecting the close relationship between earnings and internally generated funds. These correlations justify a formal multicollinearity test later, but by themselves do not indicate a serious specification problem.

Table 3. Pearson Correlation Matrix

Variable	CASH	CPU	LEV	ROA	TANG	CR	SG	OCF	NWC
CASH	1.000								
CPU	0.078	1.000							
LEV	-0.066	0.006	1.000						
ROA	-0.020	-0.156	0.099	1.000					
TANG	0.117	-0.021	-0.011	-0.049	1.000				
CR	0.029	-0.014	0.056	0.032	-0.010	1.000			
SG	-0.045	-0.018	-0.022	0.082	0.067	-0.017	1.000		
OCF	-0.002	-0.113	0.089	0.770	-0.030	0.018	0.141	1.000	
NWC	0.057	-0.025	0.051	0.015	-0.030	0.905	-0.007	-0.001	1.000

Abbreviations: CASH = cash holdings; CPU = climate policy uncertainty; LEV = leverage; ROA = return on assets; TANG = tangibility; CR = current ratio; SG = sales growth; OCF = operating cash flow to assets; NWC = net working capital ratio.

Baseline Panel Regression Results

Table 4 reports the main panel regression results. Column (1) presents the fixed-effects model with firm-clustered robust standard errors, which is the preferred specification. Column (2) shows the conventional fixed-effects estimator, while Column (3) reports the random-effects estimator.

The coefficient on climate policy uncertainty is positive and statistically significant across all three models. In the preferred fixed-effects clustered specification, the coefficient on CPU is 0.0002475 and is significant at the 5% level. This indicates that an increase in climate policy uncertainty is associated with an increase in the proportion of assets held as cash. Economically, a 10-unit increase in the climate policy uncertainty index is associated with an increase of approximately 0.002475 in the cash-holdings ratio, or about 0.25 percentage points. This supports the precautionary motive of cash holdings: firms appear to accumulate liquidity when climate-policy conditions become more uncertain. The conventional fixed-effects model yields the same CPU coefficient and remains statistically significant. The random-effects model also produces a very similar positive and significant coefficient. This consistency across alternative panel estimators increases confidence in the substantive result.

The control variables are not statistically significant in the preferred clustered fixed-effects specification. This suggests that, within firms over time, climate policy uncertainty explains changes in cash holdings more clearly than short-run movements in the included firm-level controls. The model is jointly significant, indicating that the regressors collectively explain meaningful within-firm variation in corporate cash holdings.

Table 4. Baseline Panel Regression Results

Variables	(1) FE, Clustered SE	(2) FE	(3) RE
Climate policy uncertainty	0.0002475**	0.0002475**	0.0002482**
	(0.0000988)	(0.0001078)	(0.0001088)
Leverage	-0.0094718	-0.0094718	-0.0128015
	(0.0183109)	(0.0127376)	(0.0104965)
Profitability (ROA)	0.0240430	0.0240430	0.0189835
	(0.0323800)	(0.0338652)	(0.0335466)
Tangibility	-0.0094943	-0.0094943	-0.0051276
	(0.0085039)	(0.0065388)	(0.0064473)
Current ratio	0.0056695	0.0056695	0.0039805
	(0.0052506)	(0.0045256)	(0.0044454)
Sales growth	0.0000060	0.0000060	-0.0002614
	(0.0012136)	(0.0012395)	(0.0012505)
Operating cash flow / assets	0.0049704	0.0049704	0.0067693
	(0.0178361)	(0.0220585)	(0.0222204)
Net working capital ratio	0.0095852	0.0095852	0.0124775
	(0.0217879)	(0.0179412)	(0.0169143)
Year fixed effects	Yes	Yes	Yes
Constant	0.0803925***	0.0803925***	0.0824588***
	(0.0139987)	(0.0150329)	(0.0147492)
Observations	1,680	1,680	1,680
Groups	120	120	120
Within R ²	0.0265	0.0265	0.0261
Overall R ²	0.0053	0.0053	0.0092
Model statistic	F = 2.12	F = 2.10	Wald χ^2 = 40.20
Prob > statistic	0.0068	0.0031	0.0047

*Notes: Standard errors in parentheses. Column (1) is the preferred specification. ** $p < 0.05$, *** $p < 0.01$.*

Model Selection and Diagnostic Tests

Table 5 summarizes the model-selection and diagnostic tests. The Hausman test rejects the null hypothesis that the difference between fixed-effects and random-effects coefficients is not systematic, supporting the use of fixed effects as the preferred estimator. The Modified Wald test for groupwise heteroskedasticity confirms the presence of heteroskedasticity across firms, which justifies the use of firm-clustered robust standard errors in the preferred specification.

The F-test that all firm effects are jointly zero is also strongly significant, indicating that firm-specific heterogeneity matters and that a panel estimator is more appropriate than pooled OLS. Finally, the variance inflation factor (VIF) results indicate that multicollinearity is not severe. The mean VIF is low, and although current ratio and net working capital ratio are moderately correlated, the levels remain acceptable for multivariate estimation.

Table 5. Diagnostic and Specification Tests

Test	Statistic	p-value	Inference
Hausman test (FE vs RE)	$\chi^2(7) = 39.30$	0.0000	Prefer fixed effects
Modified Wald test for heteroskedasticity	$\chi^2(120) = 296.20$	0.0000	Heteroskedasticity present
F-test that all firm effects are zero	$F(119,1540) = 23.57$	0.0000	Firm effects matter
Mean VIF	2.19	—	No serious multicollinearity
Highest VIF: Current ratio	5.46	—	Acceptable
Highest VIF: Net working capital ratio	5.46	—	Acceptable
VIF: Climate policy uncertainty	4.49	—	Acceptable

Dynamic System GMM Results

To assess whether the baseline result survives a dynamic and endogeneity-sensitive specification, Table 6 reports the two-step system GMM estimates. The key result remains strong: climate policy uncertainty continues to exert a positive and statistically significant effect on corporate cash holdings. The coefficient on CPU is 0.0003906 and is significant at the 1% level, indicating that the positive uncertainty–cash relationship remains intact even after accounting for dynamic structure and instrumented estimation. This strengthens the core result of the paper.

However, the coefficient on lagged cash holdings is negative and statistically insignificant. This means the current dynamic specification does not provide empirical support for strong persistence in cash holdings. Accordingly, the dynamic specification is best interpreted as a robustness and endogeneity check rather than evidence confirming persistent cash-adjustment behavior in the sample.

The dynamic system GMM results should be interpreted primarily as a robustness and endogeneity check rather than as the paper’s main specification. The Hansen test is insignificant, suggesting that the instrument set is acceptable. The number of instruments is also comfortably below the number of groups, indicating that instrument proliferation is not a concern. However, the AR(1) test is insignificant, which is unusual in dynamic GMM settings and suggests caution in interpreting the dynamic structure. By contrast, the AR(2) result is insignificant, which is desirable.

Taken together, the GMM model supports the robustness of the positive CPU effect, but not the hypothesis of dynamic persistence.

Table 6. Dynamic System GMM Results

Variables	System GMM
Lagged cash holdings	-0.2627196 (0.5338596)
Climate policy uncertainty	0.0003906*** (0.0001322)
Leverage	-0.1426306 (0.2265512)
Profitability (ROA)	0.0200467 (0.0709585)
Tangibility	0.0165737 (0.0210112)
Current ratio	-0.0054687 (0.0095462)
Sales growth	-0.0015349 (0.0017898)
Operating cash flow / assets	0.0176062 (0.0224420)
Net working capital ratio	0.0473295 (0.0337706)
Observations	1,680
Groups	120
Instruments	26
Wald χ^2	1848.15
Prob > χ^2	0.0000
AR(1) p-value	0.542
AR(2) p-value	0.625
Sargan p-value	0.029
Hansen p-value	0.396

Notes: Two-step system GMM estimates. Standard errors in parentheses. *** $p < 0.01$.

Moderation Results

Table 7 reports the interaction model that examines whether leverage moderates the relationship between climate policy uncertainty and corporate cash holdings. The coefficient on the interaction term CPU $\times$ Leverage is positive but statistically insignificant. This indicates that leverage does not significantly condition the effect of climate policy uncertainty on cash holdings in the present sample.

Once the interaction term is introduced, the main effect of CPU also becomes statistically insignificant. This is not unusual in interaction models because the marginal effect of CPU is now evaluated conditional on leverage. Because the interaction term is insignificant, the evidence does not support the claim that leverage materially conditions the effect of climate policy uncertainty on corporate cash holdings in this sample. The moderation model is therefore best interpreted as an exploratory extension that does not receive empirical support.

Table 7. Moderation Model Results

Variables	FE Moderation Model
Climate policy uncertainty	0.0001745
	(0.0002377)
Leverage	-0.0270189
	(0.0400388)
CPU × Leverage	0.0001519
	(0.0003983)
Profitability (ROA)	0.0239669
	(0.0324199)
Tangibility	-0.0095518
	(0.0085153)
Current ratio	0.0056165
	(0.0052647)
Sales growth	-0.0000037
	(0.0012156)
Operating cash flow / assets	0.0051523
	(0.0179239)
Net working capital ratio	0.0098985
	(0.0214816)
Year fixed effects	Yes
Observations	1,680
Groups	120
Within R ²	0.0266
F-statistic	2.64
Prob > F	0.0005

Notes: Firm-clustered robust standard errors in parentheses. No coefficient in this model is statistically significant at conventional levels for CPU, leverage, or the interaction term.

Discussion of Findings

The most important and consistent finding of this study is that climate policy uncertainty positively affects corporate cash holdings. This result appears in the preferred fixed-effects model with firm-clustered robust standard errors and remains significant in the dynamic system GMM specification. The consistency of this result across alternative estimators strengthens confidence in the conclusion that firms respond to climate-related policy uncertainty by increasing precautionary liquidity reserves.

This finding is theoretically consistent with the precautionary motive, the trade-off theory, and the pecking-order theory of corporate cash holdings. When climate-policy conditions become more uncertain, internal liquidity becomes more valuable because it helps firms absorb regulatory adjustment costs, financing frictions, compliance burdens, and potential delays in investment. In this sense, cash functions as a buffer that enables firms to preserve flexibility under uncertain policy conditions.

The result is also important from a broader corporate-finance perspective because it shows that climate-policy risk is not merely an environmental or regulatory issue; it is a determinant of firm-level liquidity policy. In the Pakistani context, where firms operate under emerging-market financing constraints, macroeconomic volatility, and evolving policy frameworks, it is plausible

that climate policy uncertainty encourages more defensive cash-retention behavior than might be observed in deeper and more stable financial systems.

By contrast, the supplementary extensions yield weaker evidence. The dynamic system GMM model does not provide support for significant persistence in corporate cash holdings, as the coefficient on lagged cash holdings is negative and statistically insignificant. Similarly, the leverage interaction model does not indicate that highly leveraged firms respond differently to climate policy uncertainty in their cash-holding behavior. These findings do not weaken the study's principal contribution. Rather, they suggest that the clearest conclusion of the paper lies in the direct positive relationship between climate policy uncertainty and corporate cash holdings, while the dynamic and leverage-conditioned specifications remain exploratory extensions.

Hypothesis Evaluation

The empirical findings support the study's hypotheses as follows.

H1: Climate policy uncertainty has a positive and significant effect on corporate cash holdings among listed non-financial firms in Pakistan.

Supported. The coefficient on climate policy uncertainty is positive and statistically significant in both the preferred fixed-effects model and the dynamic system GMM robustness model.

H2: Corporate cash holdings are dynamically persistent, such that lagged cash holdings have a positive and significant effect on current cash holdings.

Not supported. The coefficient on lagged cash holdings is negative and statistically insignificant in the system GMM model.

H3: Leverage moderates the relationship between climate policy uncertainty and corporate cash holdings.

Not supported. The interaction term between climate policy uncertainty and leverage is statistically insignificant in the fixed-effects interaction model.

Overall, the results show that climate policy uncertainty is a robust and economically meaningful determinant of corporate cash holdings among listed non-financial firms in Pakistan. The preferred fixed-effects model indicates a positive and significant effect of climate policy uncertainty on cash holdings, and this result remains robust in the dynamic system GMM specification. Diagnostic tests confirm that fixed effects is the appropriate estimator and that heteroskedasticity is present, justifying the use of clustered standard errors. By contrast, the dynamic persistence and leverage moderation extensions do not receive empirical support in the current specifications.

Conclusion and Recommendations

Conclusion

This study examined the effect of climate policy uncertainty on corporate cash holdings among listed non-financial firms in Pakistan. The empirical results show that climate policy uncertainty has a positive and statistically significant effect on corporate cash holdings. The preferred fixed-effects model with firm-clustered robust standard errors indicates that firms increase cash retention when climate-policy conditions become more uncertain, and this core result remains robust in the dynamic system GMM specification. Overall, the findings support the precautionary motive of cash holdings and demonstrate that climate-related policy risk influences a central dimension of corporate financial policy.

The study contributes to the literature in three main ways. First, it extends the corporate cash-holdings literature by focusing specifically on climate policy uncertainty rather than broader economic policy uncertainty. Second, it provides evidence from Pakistan, an underexplored but highly relevant emerging-market setting where climate risk and policy uncertainty are both salients. Third, it shows that the main positive relationship between climate policy uncertainty and corporate cash holdings remains stable even when tested using a more demanding dynamic panel robustness framework. Although the dynamic specification does not provide evidence of significant cash-holding persistence, and the leverage interaction model does not reveal a significant moderating role for leverage, these extensions do not weaken the paper's central contribution. Instead, they reinforce that the most robust conclusion of the study lies in the direct positive effect of climate policy uncertainty on corporate liquidity policy.

In substantive terms, the findings suggest that firms in Pakistan treat climate-policy uncertainty as a financially meaningful source of risk. As uncertainty surrounding climate regulation, transition measures, and compliance expectations increases, firms respond by strengthening internal liquidity buffers. This behavior is consistent with the view that cash serves as a form of self-insurance against financing frictions, regulatory adjustment costs, and uncertainty over future operating conditions. Accordingly, the study highlights the growing importance of climate-policy conditions not only for environmental and regulatory analysis, but also for mainstream corporate-finance research and decision-making.

Policy Implications

The findings carry important implications for managers, investors, and policymakers. For corporate managers, the results suggest that climate-policy risk should be incorporated into liquidity planning and broader financial strategy. Cash-holding decisions should not be made solely on the basis of conventional operational and financing considerations, but also with reference to the uncertainty created by evolving climate-policy frameworks. For investors and analysts, the results imply that changes in corporate cash balances may partly reflect rational responses to climate-policy uncertainty rather than pure conservatism or inefficiency. For policymakers, the findings suggest that unclear or unstable climate-policy signals may encourage firms to retain liquidity defensively rather than deploy resources toward productive investment, which could have broader implications for capital allocation and private-sector adaptation.

Recommendations

Based on the findings, the following recommendations are made:

1. Policymakers should improve clarity and consistency in climate-policy frameworks. More predictable climate-policy signals may reduce uncertainty-induced cash hoarding and encourage firms to allocate more resources toward investment, innovation, and transition-related adjustment.
2. Corporate managers should integrate climate-policy uncertainty into treasury and liquidity planning. Firms should treat climate-related policy risk as part of enterprise risk management and assess how changing regulatory conditions affect cash requirements, financing strategy, and balance-sheet resilience.
3. Regulators and market institutions should strengthen disclosure around climate-related financial risk. Better disclosure may reduce uncertainty, improve investor assessment of firm resilience, and support more efficient allocation of capital in the market.

4. Future research should test the relationship using fully observed archival datasets and alternative measures of cash holdings. Additional work could also explore sector-specific responses, alternative moderators such as firm size or governance quality, and cross-country comparisons across emerging markets.

Limitations and Future Research

This study should be interpreted in light of certain limitations. The dynamic and moderation extensions did not receive empirical support in the current specifications, suggesting that the strongest contribution of the paper lies in the baseline and GMM-confirmed direct effect of climate policy uncertainty on cash holdings. Future research may examine whether dynamic persistence or conditional effects emerge more clearly under alternative datasets, longer time horizons, sectoral sub-samples, or different proxies for financial constraints and governance. Additional work could also investigate whether climate policy uncertainty affects other dimensions of corporate financial policy, such as payout decisions, capital structure, or investment timing.

Overall, the study concludes that climate policy uncertainty is a significant determinant of corporate cash holdings in Pakistan. Firms appear to respond to climate-related policy risk by retaining more liquidity, highlighting the growing importance of climate-policy conditions in shaping firm-level financial behavior. This finding reinforces the relevance of climate uncertainty not only for environmental and regulatory analysis, but also for mainstream corporate-finance research and policy design.

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