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Uncertainty and Corporate Cash Holdings:

Evidence From Saudi-Listed Companies

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Uncertainty and Corporate Cash Holdings: Evidence From Saudi-Listed Companies*

Abstract

This paper examines the effect and implications of uncertainty on corporate cash holdings of all Saudi publicly-traded firms over the period 2003-2021, using the panel error correction model (ECM) by utilizing the quarterly uncertainty indices of Saudi Arabia, emerging markets, and the Middle East and Central Asia (MECA), constructed by Ahir et al. (2022). We found that there is significant statistical evidence of a positive long-run and short-run impact, only for the Saudi and MECA uncertainty Indices on firms' cash holding. Our results are robust to controlling for a group of firm-level, Saudi-specific, macroeconomic, and governance indicators. In line with Baker (2016), we assume that high levels of uncertainty are correlated with less investment and more cash holding. We also found that uncertainty in emerging economies is negatively associated with levels of cash held in Saudi firms' vaults due to fewer investment opportunities in emerging markets. Therefore, not only does our study contribute to the previous work on the impact of uncertainty on firms' decisions to hold more cash but also to the incomplete work examining such relationships in Saudi Arabia.

Keywords: Financial Market, Cash Holdings, Uncertainty, Error Correction Model, Saudi Arabia

JEL Classifications: *C1, C33, G0, G32, G38*

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1. Introduction

Cash or cash equivalents are crucial assets on companies' balance sheets and gain substantial consideration from all economic agents, i.e., companies, investors, and financial analysts. Several dynamic factors determine firms' financial decisions in terms of expanding investments or holding liquid assets. Theories related to firms' purposes of holding liquid assets have evolved throughout history. These theories are mostly categorized into three main approaches. First, there is the 'trade-off theory approach,' which balances marginal costs and benefits by targeting a certain cash level. Under the trade-off theory, the motives behind firms holding liquid assets are to avoid the transactional cost, maintain a buffer against unknown circumstances, and have the privilege of taking advantage of profitable investment opportunities (Keynes, 1936; Baumol, 1952; Opler et al., 1999; Ferreira and Vilela, 2004; Foley et al., 2007). Second, unlike the trade-off theory, the "pecking order" theory motivations stem from the idea that cash is needed to finance investment needs, although that the pecking order theiry does not target a certain level of cash in the firms' vault. As explained by Myers (1984), the pecking theory depends on an asymmetric information theory, which aims to minimize financing costs and asymmetric information. In other words, cash holding is considered the first source of financing before debt or issuing equity. Third, the 'free cash flow theory' ' also known as Agency Theory' indicates that the motive behind holding cash is that firms' managers generally prefer to accumulate more liquid assets (Jensen, 1986). Holding extra liquid assets would give managers more discretionary power when making investment decisions.

"*Free cash flow is cash flow in excess of that required to fund all projects that have positive net present values when discounted at the relevant cost of capital*" (Jensen, 1986, p. 323).

A company may not need to make as much effort to allocate alternative sources of liquid assets to finance its potential initiatives if it has more cash on its balance sheet and is, therefore, likely to be managed well.

Overall, the three different cash holding theories are highly dependent on the level of uncertainty, and the motivation of holding cash, explicitly or implicitly, has an interlocking relationship with uncertainty surrounding firms. Recently, several studies investigated the effect of uncertainty on corporates' cash holding (Liu et al., 2021; Li, 2019; Duong et al., 2018). The common general definition of uncertainty in literature is the changes in policies and regulations that would affect the financial decisions of firms. These policies may relate to any regulatory policies, including fiscal and monetary policies (Istrefi and Piloiu, 2014). Also, uncertainty refers to difficulty in perfectly anticipating the probability of an event (Goodell et al., 2021). The vast majority of the research in this field generally supports the existence of a positive link between firms' cash holdings and macroeconomic uncertainty, which means that when uncertainty increases, firms lean towards increasing their cash holding (Saumitra et al., 2011; Baum et al., 2006 and 2008).

Considering the Saudi context and the Saudi uncertainty fluctuation, it is important to point out that not only does it necessarily reflect a specific policy but also includes the announcement of its implementation. Given the Saudi economy structure in which the externality effect plays a role in the level of uncertainty, the relationship between firms' cash holdings and uncertainty is worth investigating. In fact, the Saudi economy has been in a transition period coupled with uncertainty; therefore, it is crucial to study uncertainty's impact on firms' cash holdings.

Thus, this paper examines the empirical effects of macroeconomic uncertainty on firms' cash holdings in the case of Saudi Arabia by using several uncertainty indices that have been previously used by other

authors. In terms of model specification, we control for macroeconomic and firm-level characteristics by including financial, macroeconomic and governance characteristics to get the exact impact coming from uncertainty. The research sample consists of all Saudi-listed firms and covers the period between 2003 and 2021. Given the fact that the literature lacks studies that examine the relationship between firms' cash holdings in Saudi Arabia and macroeconomic uncertainty, the main focus of this paper is to quantify the impact of uncertainty on cash holdings in Saudi Arabia. The rest of the paper is structured as follows: The second section presents the dynamics of cash holdings and uncertainty in the Saudi economy. The third section illustrates the literature review, which consists of the theoretical background and the empirical evidence of the motives and determinants of holding different levels of cash. The fourth section explains the data and methodology utilized to examine the nexus between uncertainty and corporates' cash holding. The fifth section presents the results, interpretations, and discussions related to the estimated models. Finally, the fifth section concludes and offers some suggestions for further enhancement of future research.

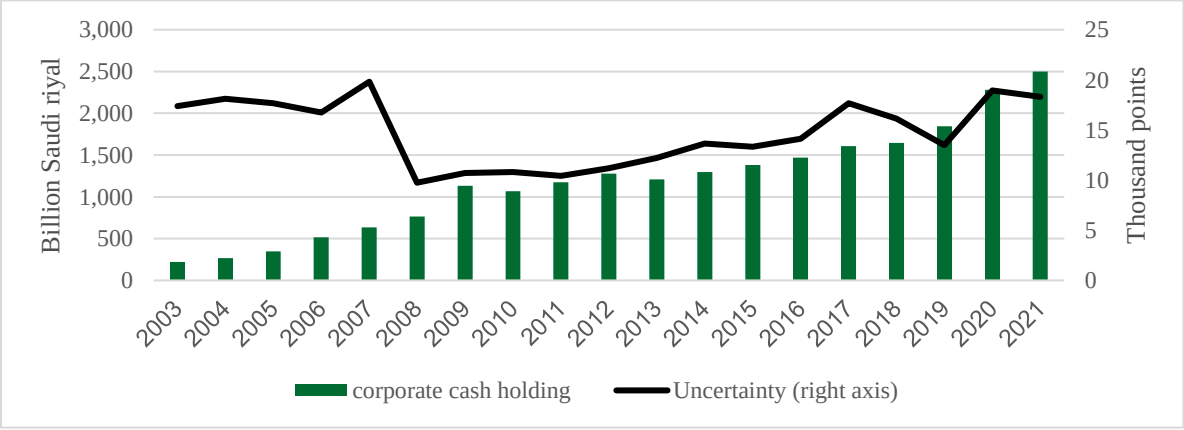
2. Cash Holdings and Uncertainty in Saudi Arabia

Since 2006, cash holding and uncertainty patterns in Saudi Arabia have been worthy of special investigation. Figure 1 shows the uncertainty index and firms' total cash holdings in Saudi Arabia from 2003 to 2021. We can see that uncertainty increased during specific periods, such as the collapse of the Saudi stock market in 2006, the adoption of economic structural change, the implementation of expat levy and dependents' fees in late 2016 and 2017, and the emergence of the Covid-19 pandemic in 2020. Moreover, we can see that there were some specific times when Saudi uncertainty decreased, such as in 2008, which might be attributed to the increase in government spending and the increase in oil prices.

Further, we can observe that corporate cash holdings surged during the 2006 stock market crash and continued to rise as a result of the 2008 global financial crisis. Therefore, the cash holdings of Saudi enterprises may be impacted by the global macroeconomic uncertainty relating to real economic operations. Additionally, at the beginning of any economic reform, uncertainty increases among economic agents. This explains the increase in firms' cash holdings during the implementation of domestic economic structural change in 2017. Furthermore, we can see that, with the exception of the oil sector, the movement of the sectors' cash holdings is connected with the movement of the Saudi uncertainty index, as illustrated in Figure 2. This might be due to the listing of Saudi Aramco Company on the Saudi Stock Market.

Figure 1

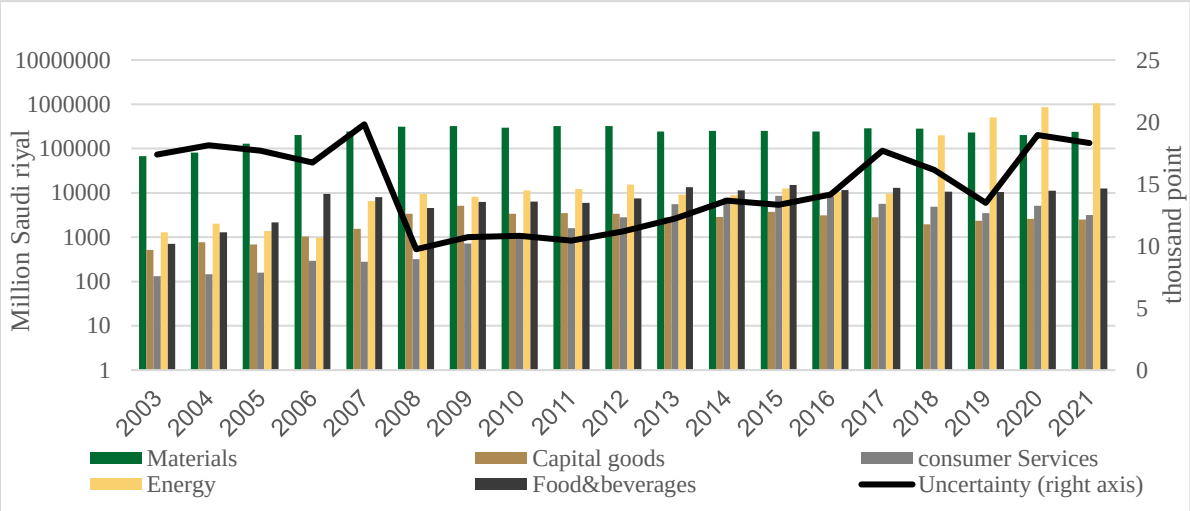
Saudi Corporate Total Cash Holdings and Saudi Uncertainty Index



Source: Argaam, Ahir et al. (2022), and World Uncertainty Index data.

Figure 2

Saudi Corporate Cash Holdings Across Selected Sectors and Saudi Uncertainty Index



Source: Argaam, Ahir et al. (2022), and World Uncertainty Index.

3. Literature Review

This section briefly discusses the theoretical ground of cash holdings and refers to three main theories: the trade-off theory, the pecking order theory and the free cash flow theory. Also, it provides an empirical background on cash holdings, consistent with the theories discussed previously. After that, we highlight the contribution of our study to the literature.

3.1 Theoretical Background

According to the corporate finance literature, various research literature focused on the factors that affect a firm's liquidity. The vast majority of research linked corporate cash holding to three theories: "trade-off theory," "pecking order theory," and "free cash flow theory." According to the trade-off theory, businesses should specify a goal level for liquidity. That level should strike a balance between

marginal cost and reserved cash utility. Corporate liquidity would be enhanced by reducing transaction costs along with the rationale of being precautious and speculative. Thus, the purpose of holding cash is to reduce transaction costs and avoid incurring the expenses of obtaining external financing. Another justification for holding cash is to support profitable investments when external sources of funds are limited and costly (Dittmar et al., 2003). However, holding cash comes at a cost. The cost would be in the form of carrying cost and the cost of managerial discretion (Ferreira and Vilela, 2004). Unlike the trade-off theory, the 'pecking order' theory was introduced by Myers (1977). Myers and Majluf (1984) ignored defining a target cash level for firms based on the belief that an optimal cash level does not exist. As an alternative, firms should allocate excess cash to retained earnings or new ambitious projects (Opler et al., 1999). Jensen (1986) introduced the 'free cash flow' theory, which indicates that executives prefer more liquidity at hand to preserve the privilege of controlling the companies' assets and have more discretionary power when making decisions about investment (Ferreira and Vilela, 2004).

3.2 Empirical Background

With respect to the relevant literature, Scott (1995) and North (1990, 2005) claimed that institutional factors, such as the presence and effectiveness of laws that are weak in emerging markets, are critical in determining cash amounts held by companies. Opler et al. (1999) studied the elements that encourage U.S. companies' accumulation of liquid assets. They observed that smaller, riskier businesses with growth potential tended to have more liquid assets stored away than larger and risk-averse businesses. So, what are the benefits that encourage firms to stay liquid or illiquid? Precautionary measures and transaction reduction are the two drivers behind retaining liquid or semi-liquid assets (Al-Najjar, 2013). Companies build up reserves when the opportunity cost of retaining more liquid assets rises (i.e., when they cannot fund initiatives because of cash deficits) (Dittmar et al., 2003; Miller & Orr,

1966; Tobin, 1956). Due to precautionary measures, even if it is easy, firms do not prefer to generate funds from external sources because of market pricing issues. Ozkan and Ozkan (2014) found in their study that firms keep enough liquidity at hand to channel these financial assets into new profitable investments when the interest rates are overly high.

One possible explanation for the fluctuations in cash levels held by companies is uncertainty. Uncertainty refers to the difficulty of anticipating the probability of an event. According to research, businesses alter most of their behavior in response to uncertain market conditions (Goodell et al., 2021). Particularly, asymmetric information and contract uncertainty have increased the transaction cost of exchange and impacted the value of genuine investment possibilities, forcing businesses to wait and gather more information before making an investment (Bernanke 1982; Williamson, 1988).

Numerous studies focused on developed countries. Opler et al. (1999) used U.S. cross-sectional data to argue that firms hold more liquid assets as a cushion so they can invest at difficult times (i.e., when the cash flow is low and the cost of borrowing is too high). Dittmar et al. (2003) used a sample of more than 11,000 companies across 45 different countries to show that 'agency problems' are important factors in determining corporates' cash levels.[2] Chen et al. (2016) incorporated the real option components in determining firms' cash holding. The real option aspects of cash holdings (i.e., Book-to-market ratio, return on average assets, and economic cycle) were investigated for U.S. firms from January 1977 to December 2013 to examine the impact on economic growth. It is found that real option proxies are negatively associated with the GDP growth rate. This would indicate that uncertainty in the economy raises cash holdings' actual option value as companies prepare for the volatility of the market.

[2] Agency problems exist when shareholders' right is not protected.

When it comes to measuring uncertainty, most research used macroeconomic variables or fluctuations in the stock market as a proxy. For instance, Pinkowitz et al. (2003) used the volatility of the stock market as a proxy for measuring uncertainty. Deteriorating macroeconomic conditions would significantly impact how businesses perform when deciding how much cash to hold on to. Baum et al. (2006) evidentially proved that policymakers (managers) would struggle to anticipate firm-specific information under unstable/volatile macroeconomic conditions. On the other hand, managers would act irrationally and base their choice of liquidity assets on the needs of the firms during stable macroeconomic periods. In a similar line, Baum et al. (2008) showed that when macroeconomic uncertainty in the U.S. increases, firms will increase the size of available liquidity. In India, Saumitra et al. (2011), who utilized the same uncertainty measure used by Baum et al. (2006, 2008), examined the behavior of firms in keeping less or more cash during times of macroeconomic uncertainty. They revealed that firms in India react to high levels of uncertainty by raising their level of cash holdings.

Although similar to macroeconomic uncertainty, political uncertainty could play a role in shaping cash vaults. Does political uncertainty matter for cash holdings? Xu et al. (2016) answered this question by examining the Chinese case.[3] They found that firms feel more confident during the first months of the elected governor, thus, hold less cash.

Wright (2015) revealed, by using two uncertainty approaches, mainly long-term uncertainty (i.e., taking the first difference of the lagged 1-year and the 30-day market fluctuations) and short-term uncertainty (i.e., taking the lag of the 30-day market fluctuations or the lagged 30-day firm fluctuations),

[3] The political turnover in a city where the firm is located is the proxy that has been used to measure political uncertainty.

that levels of cash holdings have been strongly impacted by long-term firm uncertainty; however, negatively impacted by market short-term and long-term uncertainty.

Culture plays a crucial role in determining financial decisions, i.e., managers in societies dominated by a risk-averse country possess more cash compared to those in a risk-averse country (Kritzman et al.,2001). In this context, Ramirez and Tadesse (2011) examined how firms avoid uncertainty's consequences by deciding to hold on to more cash. In their study, it has been found that the less risk-averse the country is, the higher the holdings of liquid assets. Chen et al. (2015) attributed the nexus between cash level holdings and risk-averse countries to the precautious behavior exercised in such countries. Gulen and Lon (2017) revealed that, indeed, at the firm and industry level, cash holdings increase during uncertain times. Similarly, Goa and Grinstein (2014) discussed that not only did the macroeconomic indicators impact the overall uncertainty index but also created a critical impact on the firms' target of cash. Goa and Grinstein (2014) showed that U.S. enterprises store more cash when macroeconomic uncertainty is high. They achieved this by using economic policy uncertainty as a proxy for macroeconomic uncertainty. Demir and Ersan (2017) used the economic policy uncertainty index that was created by Baker et al. (2016) and investigated the influence on cash holding decisions of enterprises in order to more precisely examine the impact of economic policy uncertainty on cash holdings in certain countries (BRIC nations). The study was based on firm-level data for Brazil, Russia, India, and China (BRIC countries) over the period 2006-2015. The result showed that enterprises opt to keep more cash as the degree of uncertainty increases. By looking at the impact on credit growth, Bordo et al. (2016) examined the relationship between credit and uncertainty in the U.S. at both the aggregate level and across individual financial intermediaries from 1961 Q4 to 2014 Q3. They alluded that credit growth struggled during uncertain times. Furthermore, by looking at multi-national corporations in 49 different countries

for the period 1990-2004, Ramirez and Tadesse (2009) conducted a study to examine how the relationship between risk-averse societies and cash holdings evolves. The culture and internationalization of firms appeared to determine the amount of cash held by a firm. Although the multinationalization of firms mitigates the magnitude of the effect of uncertainty on cash holdings, companies seem to hold more cash in countries with high uncertainty avoidance.

Considering country-specific investigation of firms' cash holding and its determinants, several studies were conducted within the last decade. Al-Najjar (2013) used a static panel data estimator in the context of a country-specific analysis and claimed that the financial determinants (such as dividends, capital structure, and firm size) of corporate cash holding in developing (emerging) markets in Brazil, Russia, and China are important. Al-Najjar and Clark (2017) used 430 firms in the MENA region (of which 81 were Saudi non-financial firms) for the period 2003-2009 to show that internal and external corporate governance practices are critical in the firm's decision on cash holding. In particular, cash holdings decrease as the board size increases. However, for external governance, firms belonging to countries with international standards of securities laws and bank supervision tend to hold more cash.

By employing a static and a dynamic panel data analysis, Guizani (2017) analyzed a sample of Saudi firms over the period 2006-2014 to show that financial determinants are critical in determining cash holding. In particular, cash payouts volatility, networking capital (NWC), capital expenditure, leverage, firm size, and capital expenditure are all important factors in encouraging domestic enterprises to quickly adjust their cash holding to a certain target. Additionally, Alnori (2020) scrutinized how non-financial firms performed while keeping different levels of cash in Saudi Arabia over the period 2005-2016. The analysis was based on an unbalanced panel sample of 129 firms, with 1,012 firm-year observations, and utilized a dynamic generalized method of moments (GMM) estimator as well as

pooled ordinary least square (POLS) regression with industry fixed effect. The study results were consistent with the trade-off theory by illustrating a positive linear relationship (i.e., when financial performance prospers, cash holdings increase). When studying the non-linear U-shaped relationship, the study revealed an inverse U-shaped association between firms' cash holdings and financial performance. This approach validated the trade-off hypothesis of the appropriate cash quantity based on the non-linear connection, which holds that enterprises with high levels of cash holdings are performing worse than those with low levels, and vice versa.

Although sufficient literature addressed the factors that influence how much cash corporations hold, these factors tend to be institutional and financial in nature. In other words, the previous literature limited their endeavor to scrutinize the impact of uncertainty on financial (cash, roa, roe, etc.) and institutional variables (i.e., external and interior governance). In this way, by reviewing earlier research on the relationship between firms' cash holdings and their determinants for the case of Saudi Arabia, our study will add to the body of knowledge by looking at the effect of uncertainty on cash holdings of all publicly traded companies using a sample of 185 firms over the period 2003–2021 with quarterly frequencies. Following Arfan et al. (2017), the study utilizes the error correction model to investigate the mentioned relationship.

4.Data and Methodology

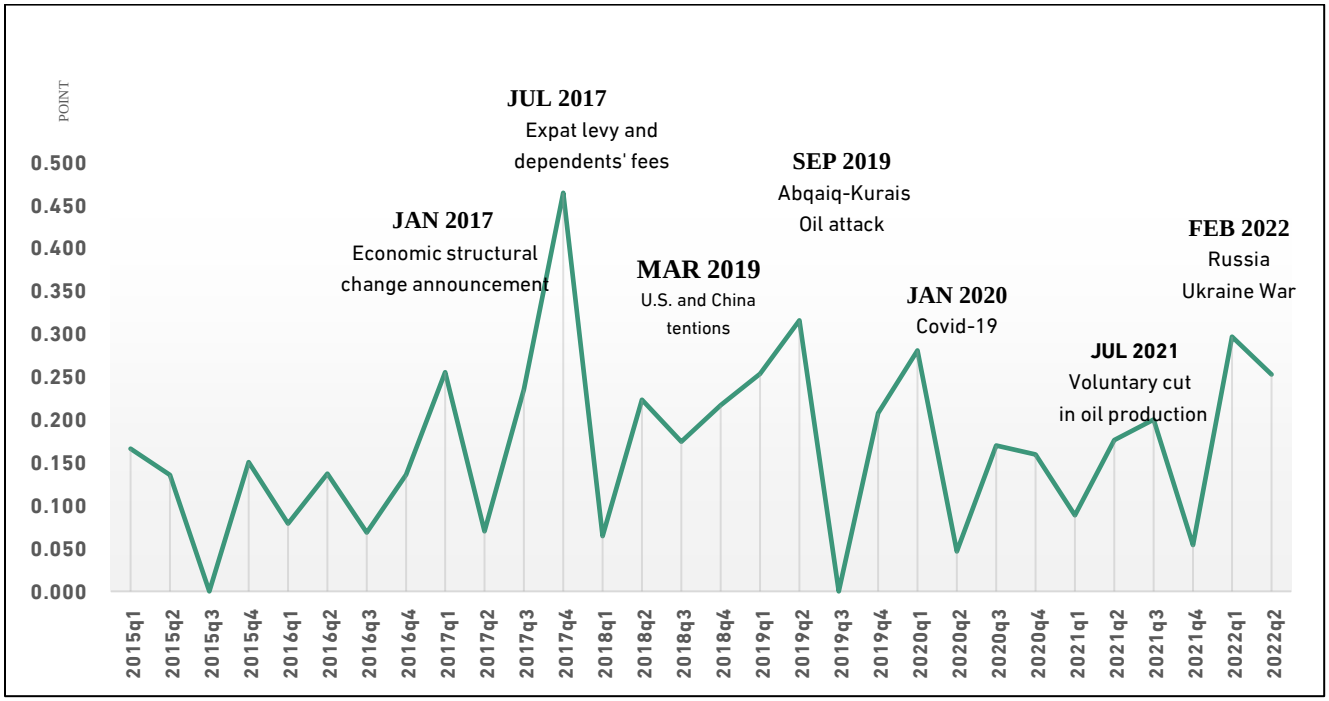
4.1Data

The study investigates the relationship between uncertainty and cash-to-assets ratio via an unbalanced panel data analysis covering 185 firms listed in Tadawul All Share Index (TASI) over the period 2003 Q1-2021 Q4 (selection of years is limited to data provided by Argaam database). The analysis included several quarterly data series, retrieved and calculated from Argaam database, such as total cash,

total assets, return on assets (ROA), leverage, market-to-book value, revenue growth, retained earnings, and net income. Uncertainty indices for Saudi Arabia, emerging markets, and MECA are all derived from Ahir et al. (2022) and covered the period (2003 Q1 – 2021 Q4). The uncertainty index of Saudi Arabia is calculated by counting the ratio of the word "uncertain" (or its variant) in the Economist Intelligence Unit country reports (EIU). The index is then rescaled by multiplying by 1,000,000. A higher number means higher uncertainty and vice versa. Figures 3 and 4 illustrate the uncertainty index for Saudi Arabia and the world by highlighting important events that led to hikes. Unlike the Economic Policy Uncertainty (hereafter EPU) that was constructed by Baker et al. (2016), the World Uncertianty Index (hereafter WUI) uses one single source (EIU), while EPU constructs the index by considering several newspapers.

Figure 3

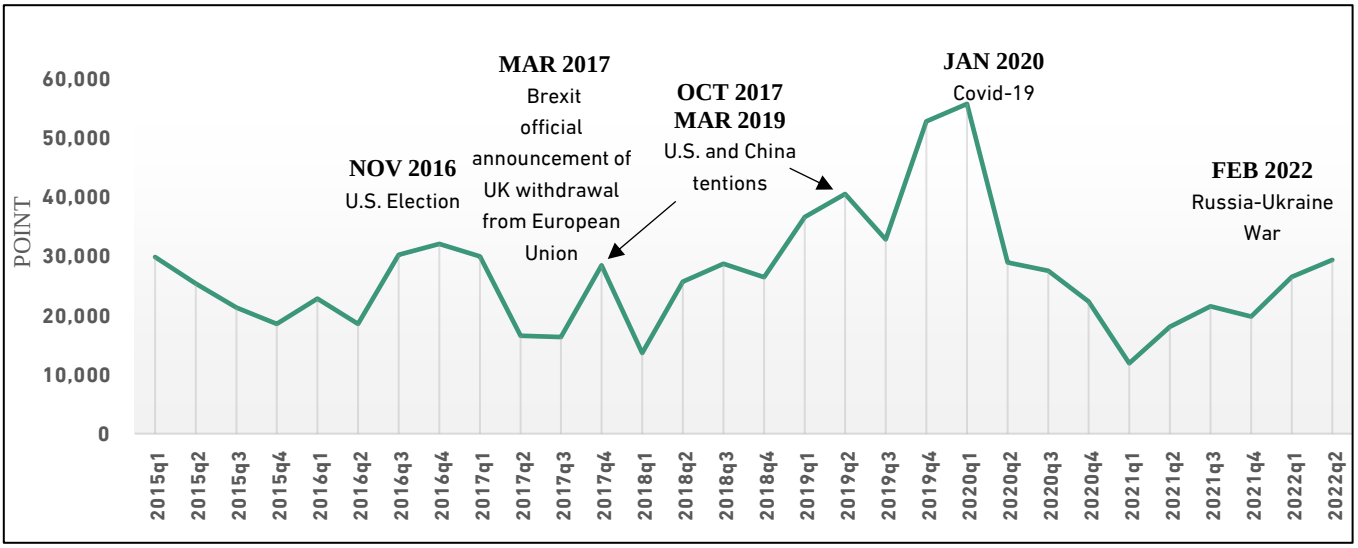
The Quarterly Saudi Uncertainty Index



Source: World Uncertainty Index.

Figure 4

The Quarterly World Uncertainty Index



Source: World Uncertainty Index.

The nominal oil gross domestic product (GDP), GDP for non-oil activities, and GDP for government services data were obtained from the General Authority of Statistics (GASTAT). Additionally, data on the rule of law were derived from World Governance Indicators (WGI). However, to be consistent with the data in the model, the annual value of WGI is used four times a year to represent the quarter of interest. The standard deviations of all the variables have been considered to ensure a unified scale of the variables. Table 1 illustrates a summary of descriptive statistics of the variables. The mean of cash-to-asset and Saudi uncertainty are 0.17 and 14764, and they range from 0 to 41 and 9078 to 23699, respectively. The uncertainty in emerging economies ranges from 6537 to 43171, while uncertainty in the Middle East and Central Asia ranges from 3918 to 28609. Notably, the Saudi uncertainty index has the highest minimum compared to emerging markets and MECA indices, while emerging economies have the highest maximum. Due to data availability, there were only 9826 observations (instead of

14060). The reason behind not having 14060 is that some firms did not have balance sheets that date back to 2003, and some did not exist yet. The same rationale applies to the number of observations of other variables.

Table 2 presents the correlation matrix for cash-to-assets when including the Saudi uncertainty index, which shows that there is no high correlation among the explanatory variables as the coefficients are less than 0.50. Also, when testing for Variance Inflation Factor (VIF), as illustrated in table 5 in the annex, the results show that the average is around 1.5 and indicates that there is a moderate correlation (Dodge, 2008). Therefore, multicollinearity should not be an issue when examining the models. Additionally, we can see that there is a positive relationship between cash holding and the Saudi uncertainty index.

Table 1

Summary Descriptive Statistics of the Variables

Variable	*Description*	*Obs.*	*Mean*	*Median*	*Std. dev*	*Min*	*Max*
$Cash_{asset}$	Cash-to-assets	9826	0.169	0.06	1.33	0	41
unc_{KSA}	Uncertainty in Saudi Arabia	76	14764.45	14737.5	3612.5	9078	23699
unc_{emrg}	Uncertainty in emerging countries	76	18718	16837	7267.8	6537	43171
unc_{MECA}	Uncertainty in the middle east and central Asia	76	13937.8	13785	5915.8	3918	28609
$leverage$	Debt to assets	9824	0.375	0.33	0.35	0	15.78
re	Retained earnings to assets	9773	0.033	0.033	0.188	-0.58	0.69
$income_{asst}$	Net income to assets	9751	-0.003	0.01	0.81	-0.62	0.27
Roa	Return on assets	9926	0.04	0.04	0.12	-2.6	0.83
$Pbook$	Market price to book value	9920	3.9	2.53	5.9	0.36	132.9
rev_{growth}	% change in revenue	9926	0.90	0.09	10.93	-3.38	405.3
gdp_{oil}	Oil activities (growth %)	44	1.5	1	7.0	-11.7	20.8

gdp_{nonoil}	Non-oil activities (growth %)	44	3.11	3.8	4.12	-10.5	9.8
gdp_{gov}	Government activities (growth %)	44	2.94	2.05	3.99	-3.9	15.3
$Rule_{Law}$	Rule of law	72	0.12	0.125	0.08	-0.01	0.34

Source: Argaam, Ahir et al. (2022), and GASTAT.

Table 2

Correlation Matrix for Cash-to-Asset

	$Cash_{asset}$	unc_{KSA}	*leverage*	*Roa*	*mktbv*	rev_{growth}	*re*	$icome_{asset}$	gdp_{oil}	gdp_{nonoil}	gdp_{gov}	$rule_{law}$
$Cash_{asset}$	1											
unc_{KSA}	0.03	1										
leverage	0.06	0.00	1									
Roa	-0.04	0.00	-0.05	1								
mktbv	0.63	0.02	0.02	-0.10	1							
rev_{growth}	-0.00	-0.03	0.01	-0.04	0.00	1						
re	-0.00	-0.04	0.01	0.05	0.01	-0.01	1					
$icome_{asset}$	-0.06	0.01	-0.02	0.28	-0.08	0.00	0.00	1				
gdp_{oil}	-0.02	-0.53	-0.02	0.00	- 0.02	0.04	0.03	-0.01	1			
gdp_{nonoil}	-0.03	-0.51	-0.01	0.01	-0.04	0.03	0.04	0.00	0.29	1		
gdp_{gov}	-0.01	-0.48	-0.01	0.02	-0.02	0.03	0.05	0.00	0.23	0.37	1	
$rule_{law}$	0.02	0.05	0.03	-0.03	0.01	-0.01	0.00	-0.01	-0.29	-0.47	-0.39	1

Source: Authors' calculation.

4.2 Model Variables

4.2.1 Dependent variable

Our dependent variable of interest is the standard deviation of cash holdings to total assets ($Cash_{asset}$). This is cash divided by the total assets of the firm at the end of the financial year.

4.2.2 Independent variables of interest

The independent variable of primary interest for this study is the uncertainty index of Saudi Arabia (Unc_{KSA}). More specifically, it is the standard deviation of the quarterly uncertainty index developed by Ahir et al. (2022).

As described by Ahir et al. (2022), the time series of the World Uncertainty Index (WUI) were classified into three levels: at the global level (simple average and GDP weighted average), income level (emerging economies), and regional level (The Middle East and Central Asia).[4] The series by income and regional level is unbalanced and uses a GDP-weighted average. All indices are computed by counting the percent of the word "uncertain" (or its variant) in the Economist Intelligence Unit country reports. The WUI is then rescaled by multiplying by 1,000,000. A higher number means higher uncertainty and vice versa. For a country-specific (Saudi Arabia) uncertainty index, we use data from the same source. However, this time series contains the count of the total number of words relating to uncertainty and its variants in the EIU reports for 143 countries from the 1950s to 2020 Q4. It is worth noting that the uncertainty index used in this study is the most recent and most developed, and it has reflected the uncertainty periods more precisely. For instance, this uncertainty index has shown particular domestic uncertainty times, such as the collapse of the stock market in 2006, which was not included in other previous uncertainty indices.

4.2.3 Control variables

Based on the relevant literature, the study includes several controls related to financial firm-level factors in Models 2, 3, and 4. These include the firms' book value-to-assets ($mktbv$) at the end of the quarter, total debt divided by assets of the firm at the end of the quarter (leverage), return of assets divided by total assets (ROA), revenue growth (rev_{growth}), total net income divided by total assets (income asset) and return earnings at the end of the quarter (re) (Opler et al., 1999 and Dittmar et al., 2003). Firms' book value-to-assets is expected to positively impact cash holdings because the higher the

[4] Emerging economies include (Argentina, Brazil, Chile, China, Colombia, Egypt, Hungary, India, Indonesia, Iran, Malaysia, Mexico, the Philippines, Poland, Russia, Saudi Arabia, South Africa, Thailand, Turkey, and the United Arab Emirates.)

value, the riskier the firm; thus, such firms tend to hold more cash to compensate for reversibility and countercyclical prices. As the debt level rises, cash level in the firm falls (Baskin, 1987), so we expect a negative relationship between leverage and cash holdings. ROA is a proxy for firms' performance. A higher ROA value indicates that the firm is profitable, hence less distressed, thus holding more cash (Chen et al. 2010). The expected sign of ROA is positive. Intuitively, rising revenue and higher levels of net income and retained earnings imply that the firm is incurring a sufficient amount of cash. Thus, the expected value of these variables is expected to be positive.

4.3 Methodology and Model Specification

Considering the possibility that uncertainty and other macroeconomic, financial, and governance characteristics could impact cash holdings by firms in the short and long run, we will be utilizing, as an empirical model, the panel error correction model (ECM) in this paper. The ECM allows for the assumption that cash-to-assets, our variable of interest, and other explanatory variables are co-integrated.[5] This means that differenced variables in our model are stationary, and they exhibit a long-run (equilibrium) relationship. In other words, the first difference between cash-to-assets and independent variables is stationary, and these variables possess a long-run (equilibrium) relationship that can be upset by disturbances that could originate some divergence in the short run (Box-steffensmeir et al., 2014; Durr, 1992).

[5] Under the cointegration assumption, a linear combination of the time-series variables must be stationary. This can be assessed by testing whether the residual of the equilibrium model is time stationary. However, Keele and De Boef (2004) highlighted that even if the cointegration assumption is not fulfilled, ECM can still be useful because it is theoretically desirable to estimate the long- and short-run effects of an independent variable separately rather than combining these processes into one variable, and ECM estimates do not significantly diverge from a standard (first-order) auto-regressive distributive lag model.

In particular, as in any ECM, we take the first difference of the dependent variable (cash-to-assets), which must be stationary, and the independent variables are included twice in the model.[6]

The baseline ECM model has been estimated as follows:

$$\Delta Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 \sum \Delta X_{i,t} + \beta_3 \sum X_{i,t-1} + \beta_4 \sum CE_i + \beta_5 \sum TE_t + \varepsilon \quad (1)$$

We take the first difference of our dependent variable $\Delta Y_{i,t}$, the cash-to-assets ratio for firm i in year t.[7] On the right hand of the equation, $Y_{i,t-1}$ is the lagged value of the dependent variable, which represents the error correction that adjusts our independent variable cash-to-assets ratio in firm i at year t-1, back to equilibrium in the long run. The error correction term must be negative and significant. If this is not the case, there will be no need to perform an ECM as there is no significant long-run adjustment, a positive error correction term indicates instability, and an insignificant value indicates that variables are not co-integrated (Box-Steffensmeir et al., 2014).

$\sum \Delta X_{i,t}$ is a vector of the first differences of all firm-level and institutional variables for firm i at time t. Therefore, β_2 captures the direct effect (short-run effect) on cash-to-assets when there is a change in the explanatory variable. The independent variables lagged in the vector $\sum X_{i,t-1}$ for firm i at time t-1. The lagged level of our independent variables is the long-run impact on changes in the dependent variable (cash-to-assets). It is important to note that the long-run effect of our explanatory variables is dependent upon their beta coefficients (β_3) and also the error correction term (β_1). β_1 is the rate of adjustment in the long run. Thus, we can compute the total long-run impact of the explanatory variables by taking the negative ratio of $\beta_3$to β_1 (Vlandas 2018). Consequently, the variable significance

[6] The study used Fisher-unit root to confirm that stationary is applied in the analysis. Also, the first-differenced variable should measure the explanatory variables' effect on cash-to-assets in the short run, while the lagged t-1 is to measure the independent's variable long-run effect on cash-to-assets.

[7] i is the individual firm dimension including 185 firms, and t is the quarterly time dimension t = 2003q1, 2006q3…,2021q4.

of the long-run effect can be determined by taking the ratio of the standard errors of our variables. To control for omitted factors that might ignite more suppressed fluctuations in the cash-to-assets that are constant over time but differ across firms, we include a vector of CE to capture the firms' fixed effects. In addition, we control for time dummies that capture the quarter/yearly shocks by including a vector of $\sum TE_t$. In essence, including time dummies allows us to control for omitted time shocks and hence would capture and control for years, leading to a common rise or decline in the level of cash-to-assets. We ran a likelihood ratio test that shows there is heteroscedasticity within our panel. Thus, we have incorporated firm clustered standard errors in our different models. In addition, all the variables were standardized to capture the long and short-run impact of our dependent variables on changes in cash-to-assets. Furthermore, due to the nature of the analysis, which is a panel data analysis, we checked the appropriate estimator regression model to be used among three popular methods: Random Effect, Fixed Effect, and Pooled OLS. The result showed that the Fixed Effect method is the most appropriate approach to be utilized.[8]

Besides the baseline model, which investigates the relationship between cash holdings and uncertainty, the study includes three models to control for other related variables.

The following equation describes the basic specification in model 2: $Cash_{asset} = \beta_0 + \beta_1 Unc_{KSA} + \beta_2 leverage + \beta_3 Roa + \beta_4 mktbv + \beta_5 rev_{growth} + \beta_6 re + \beta_7 income_{asset} + \varepsilon_{it}$ (2)

The following equation describes the basic specification in model 3: $Cash_{asset} = \beta_0 + \beta_1 Unc_{emrg} + \beta_2 leverage + \beta_3 Roa + \beta_4 mktbv + \beta_5 rev_{growth} + \beta_6 re + \beta_7 income_{asset} + \varepsilon_{it}$ (3)

The following equation describes the basic specification in model 4: $Cash_{asset} = \beta_0 + \beta_1 Unc_{MECA} + \beta_2 leverage + \beta_3 Roa + \beta_4 mktbv + \beta_5 rev_{growth} + \beta_6 re + \beta_7 income_{asset} + \varepsilon_{it}$ (4)

[8] Results for pooled and random models are ready to be shared upon request.

4.4 Robustness check

Moreover, besides controlling for financial factors, models 5, 6, and 7 control for macroeconomic and national governance factors by including the GDP for non-oil activities (gdp_{nonoil}), the oil GDP (gdp_{oil}), government activities (gdp_{gov}) and the Rule of Law measure from World Governance Indicators ($Rule_{Law}$) as a robustness check for the analysis specified in models 5, 6 and 7.

The following equation describes the basic specification in model 5: $Cash_{asset} = \beta_0 + \beta_1 Unc_{KSA} + \beta_2 leverage + \beta_3 Roa + \beta_4 mktbv + \beta_5 rev_{growth} + \beta_6 re + \beta_7 income_{asset} + \beta_8 gdp_{oil} + \beta_9 gdp_{nonoil} + \beta_{10} gdp_{gov} + \beta_{11} Rule_{Law} + \varepsilon_{it}$ (5)

The following equation describes the basic specification in model 6: $Cash_{asset} = \beta_0 + \beta_1 Unc_{emrg} + \beta_2 leverage + \beta_3 Roa + \beta_4 mktbv + \beta_5 rev_{growth} + \beta_6 re + \beta_7 income_{asset} + \beta_8 gdp_{oil} + \beta_9 gdp_{nonoil} + \beta_{10} gdp_{gov} + \beta_{11} Rule_{Law} + \varepsilon_{it}$ (6)

The following equation describes the basic specification in model 7: $Cash_{asset} = \beta_0 + \beta_1 Unc_{meca} + \beta_2 leverage + \beta_3 Roa + \beta_4 mktbv + \beta_5 rev_{growth} + \beta_6 re + \beta_7 income_{asset} + \beta_8 gdp_{oil} + \beta_9 gdp_{nonoil} + \beta_{10} gdp_{gov} + \beta_{11} Rule_{Law} + \varepsilon_{it}$ (7)

Chen et al. (2016) alluded that corporate CEOs tend to preserve cash when they observe an economic slowdown while spending cash when economic conditions prosper. The logical explanation for such behavior is the common sense that cash serves both functions of precautionary savings and helps growth opportunities. Thus, cash held by companies ought to increase when real GDP declines and decrease when real GDP inflates. Furthermore, the control of the rule of law variable helps in reflecting perceptions of the extent to which agents have confidence in, and abide by, the rule of governance and the quality of contract enforcement (Pinkowitz et al., 2003).

5.Results and Discussions

The results of the estimated models with the control of financial factors are illustrated in Table 3. We can see that in Model 1, which shows the relationship between cash holdings and Saudi uncertainty, the uncertainty coefficient is 0.01 and statistically significant at the 5% level. This indicates that there is a long-run relationship between firms' cash holdings and uncertainty. This means that, on average, a one standard deviation increase in uncertainty leads to a rise of 0.01 in the level of cash for all Saudi-listed companies in the long run. This finding is compatible with previous studies, such as Baum et al. (2008), Saumitra et al. (2011), and Gulen and Lon (2017), which revealed that an increase in uncertainty would increase firms' cash holdings.

Model 2 includes the financial firm-level controls and shows that uncertainty in Saudi Arabia exhibits a statistically significant positive impact on the level of cash holdings in Saudi-listed firms in the long run. As uncertainty in Saudi Arabia rises, firms practice precautionary measures by seeking to preserve enough cash in their vaults. The coefficient of retained earnings demonstrates long- and short-run impacts on the level of cash in Saudi-listed firms. The coefficient is 0.02 and significant at the 1% level. As the standard deviation of retained earnings increases, firms tend to keep more cash in as they are trying to maintain a buffer for more future investment. According to the *pecking theory* that was introduced by Myers (1977), firms utilize their cash holdings between retained earnings and investments. The market-to-book-value demonstrates both short- and long-run significant and negative impacts on the level of cash held by Saudi-listed firms.

Model 3 investigates the impact of uncertainty in emerging economies on cash held by Saudi-listed firms, including financial factors' controls, and reveals that uncertainty in emerging economies has a long-run statistically significant negative impact on listed corporates' cash holdings with a coefficient

of -0.01. This means that, on average, a one standard deviation increase in uncertainty leads to a decline of 0.01 in the level of cash for all Saudi-listed companies in the long run. Moreover, the retained earnings have a significant positive impact on cash holdings at a 10% level with a coefficient of 0.03 in the short run and 0.02 in the long run. Model 4 further tests the impact of uncertainty in MECA on cash held by Saudi-listed firms, including financial variables' controls. Similar to uncertainty in emerging economies, uncertainty in MECA has a significant negative impact on cash holdings in the long run at a 5% level with a coefficient of -0.01. Looking at the financial control variables results, we found that retained earnings have a significant positive impact at a 1% level with coefficients of 0.03 and 0.02 in the short and long run, respectively. Also, market-to-book value coefficients have a significant negative result at a 1% level in both the short and long run, with values of -0.03 and -0.01, respectively.

Table 3

Estimation Output of Uncertainty Impact on Cash Holdings, Including the Control of the Financial Factors

	$Cash_{asset}$			
Variable/ Model	1	2	3	4
$Cash_{asst}(t-1)$	-0.07***	*-0.07****	*-0.07****	*-0.07****
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*
ΔUnc_{KSA}	0.00	*0.00*		
	(0.00)	*(0.00)*		
$Unc_{KSA}(t-1)$	*0.01***	*0.01***		
	(0.00)	*(0.00)*		
ΔUnc_{emrg}			-0.00	
			(0.00)	
$Unc_{emrg}(t-1)$			-0.01*	
			(0.00)	
ΔUnc_{MECA}				*-0.00*
				(0.00)
$Unc_{MECA}(t-1)$				*-0.01***
				(0.00)
$\Delta Leverage$		*-0.02*	*-0.02*	*-0.02*
		(0.02)	*(0.02)*	*(0.02)*
Leverage (t-1)		*-0.01*	*-0.01*	*-0.01*
		(0.01)	*(0.01)*	*(0.01)*
$\Delta Incasst$		*0.00*	*0.00*	*0.00*
		0.00	*(0.00)*	*(0.00)*
Incasst(t-1)		*0.00*	*0.00*	*0.00*
		0.00	*(0.00)*	*(0.00)*
$\Delta REasst$		*0.02****	*0.03****	*0.03****
		(0.00)	*(0.01)*	*(0.01)*
REasst(t-1)		*0.02****	*0.02****	*0.02****
		(0.00)	*(0.01)*	*(0.01)*

Δmktbk	*-0.03****	*-0.03*	*-0.03****
	(0.00)	*(0.00)*	*(0.01)*
Mktbk(t-1)	*-0.01***	*-0.01*	*-0.01****
	(0.00)	*(0.00)*	*0.00*
ΔRev_gwth	*-0.00*	*-0.00*	*-0.00*
	(0.01)	*(0.00)*	*(0.01)*
Rev_gwth(t-1)	*0.00*	*-0.00*	*-0.00*
	(0.00)	*(0.00)*	*(0.00)*
ΔRoa	*0.00*	*-0.00*	*-0.00*
	(0.00)	*(0.01)*	*(0.01)*
Roa (t-1)	*0.00*	*0.00*	*-0.00*
	0.01	*(0.01)*	*(0.00)*

Note: *** significant at 1% ** significant at 5% * significant at 10%; the values of standard errors are in parentheses.

Table 4 reports the results of models 5, 6, and 7, including the control for national governance and macroeconomic indicators as a robustness check for our study. We control for national governance by adding the variable Rule of Law to reflect household confidence and abidance by the rule of society and the quality of contract enforcement. We also control for macroeconomic country-specific variables by including the GDP growth standard deviation for non-oil activities, oil activities, and government services.

Similar to the previous order of models, the difference among the models is mainly the inclusion of uncertainty. Model 5 includes the impact of Saudi uncertainty, Model 6 includes the impact of emerging economies' uncertainty, and Model 7 includes the impact of the Middle East and Central Asia's uncertainty on cash holdings.

Saudi uncertainty demonstrates both the long- and short-run impact of uncertainty on cash holdings, with significant coefficients of 0.004 and 0.003 at 1% and 10%, respectively. This means a rise in uncertainty in Saudi Arabia results in an immediate increase in cash holding by firms. However, uncertainty in emerging economies demonstrates a negative impact of uncertainty on cash holding. A one standard deviation increase in uncertainty in emerging economies decreases the level of cash holding by 0.001 in the long run. This could be attributed to Saudi firms' behavior; when the level of uncertainty rises in the emerging market, they increase their investment in the domestic economy, thus

pouring extra cash. Also, there is always a positive relationship between emerging market uncertainty and oil price. The latter has a negative relationship with the Saudi firms' level of cash. Historically, in the period when the oil price was high, firms kept less cash because of the nature of government spending, which increased the cash at hand. This negative relationship is absent when the level of uncertainty rises in the Middle East and Central Asia. The coefficient of uncertainty in Central Asia and the Middle East is 0.003 and significant at a 1% level. The justification for this opposite behavior is that Saudi firms realize the greater transmission of uncertainty in neighboring countries (the Middle East and Central Asia) to Saudi Arabia. If the uncertainty level is present in neighboring countries, it will most likely be transferred to Saudi Arabia. This is why we see an impact in the short run only.

The growth of non-oil activities demonstrates a short-run impact on the cash holding of Saudi-listed companies with a coefficient of 0.005 and a significance of 5% level. The growth of government activities demonstrates a short-run impact on cash holding with a coefficient of 0.007 and a significance of 10%.

Table 4

Estimation Output of Uncertainty Impact on Cash Holdings, Including the Control of the Financial Factors, Macroeconomic Variables, and National Governance

$Cash_{asset}$ Model	5	6	7
$Cash_{asst}(t-1)$	*-0.12***	*0.12***	*0.12***
	(0.00)	*(0.00)*	*(0.00)*
ΔUnc_{KSA}	*0.004***		
	(0.00)		
$Unc_{KSA}(t-1)$	*0.003**		
	(0.00)		
ΔUnc_{emrg}		*0.00*	
		(0.00)	
$Unc_{emrg}(t-1)$		*-0.00**	
		(0.00)	
ΔUnc_{MECA}			*0.003***
			(0.00)
$Unc_{MECA}(t-1)$			*0.00*
			(0.00)
$\Delta Leverage$	*0.01***	*-0.01***	*-0.01***
	(0.00)	*(0.00)*	*(0.00)*
Leverage (t-1)	*-0.00*	*-0.00*	*-0.00*
	(0.00)	*(0.00)*	*(0.00)*

ΔInc_{asst}	-0.00**	-0.002**	-0.002**
	(0.00)	(0.00)	(0.00)
$Inc_{asst}(t-1)$	-0.00***	-0.004***	-0.004***
	(0.00)	(0.00)	(0.00)
ΔRE_{asst}	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)
$RE_{asst}(t-1)$	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
$\Delta mktbk$	-0.06***	-0.06***	-0.06***
	(0.00)	(0.00)	(0.00)
$Mktbk(t-1)$	-0.004***	-0.004***	-0.004***
	(0.00)	(0.00)	(0.00)
ΔRev_gwth	-0.00	-0.002*	-0.00
	(0.00)	(0.00)	(0.00)
$Rev\_gwth(t-1)$	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
ΔRoa	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
$Roa\ (t-1)$	0.002*	0.002*	0.002*
	(0.00)	(0.00)	(0.00)
ΔGDP_{oil}	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
$GDP_{oil(t-1)}$	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
ΔGDP_{nonoil}	0.00**	0.00**	0.00**
	(0.00)	(0.00)	(0.00)
$GDP_{nonoil(}(t-1)$	0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)
ΔGDP_{gov}	0.00*	0.00*	0.00*
	(0.00)	(0.00)	(0.00)
$GDP_{gov}(t-1)$	0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)
$\Delta Rule\_law$	0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)
$Rule\_law(t-1)$	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)

Note: *** significant at 1% ** significant at 5% * significant at 10%; the values of standard errors are in parentheses.

6. Conclusion

This study investigated the impact of uncertainty on the firm's cash holdings by utilizing unbalanced penal data and using the ECM. In the estimated models, and after controlling for a wide array of governance and macroeconomic indicators, we discovered a substantial correlation between uncertainty and cash holdings. In general, results across a variety of models, tests, and measures affirmed that there is an impact of uncertainty on firms' cash holdings.

We also investigated alternative measures of uncertainty indices and cash holdings. For alternative measures of uncertainty, we used the standard deviation of other uncertainty indices, such

as MECA and emerging markets (EMs). For alternative levels of cash holdings, we used the standard deviation of retained earnings. Across these tests, the standard deviation of the Saudi uncertainty index has a statistically significant impact on firms' cash holdings. In addition, we tested the relative importance of the various uncertainty indices on Saudi firms' cash holdings. According to this investigation report, Saudi Arabia's level of uncertainty has the biggest and most significant impact on cash levels.

The results of this investigation are consistent with the free cash flow theory, which offers managers discretionary power when making investment decisions, especially when one considers the Saudi economy's dependence on oil and how it operates. In a sense, when there is a positive insight about the oil sector, firms and businesses, in general, do not need to hold more cash, and vice versa, because they anticipate more government expenditure. This, in turn, would generate more demand, which would drive businesses to increase their investment to meet the higher level of demand (Keynes, 1936). As observed by Demir and Ersan (2017), Goa and Grinstein (2014), Baker et al. (2017) and many other authors, uncertain times can affect corporates' cash holding levels.

The study examined uncertainty in developing economies, the Middle East, and Central Asia in addition to country-specific uncertainty. We discovered that while high uncertainty in emerging economies, the Middle East and Central Asia discourages businesses from investing abroad, it encourages local businesses to hold more cash in vaults. As a result, businesses prefer to invest more locally and keep less cash on hand. However, the effect of uncertainty in some nations has not been taken into consideration. This study has examined the impact of economic uncertainty on all publicly listed corporates' cash holdings in Saudi Arabia from 2003 to 2021 by utilizing the panel error correction

model. To the best of our knowledge, the study contribution has not been investigated in previous literature.

Future investigation may focus on the financial sector, including banking and insurance industries. Additionally, synthetic control may be used to assess the models' robustness by estimating the coefficients of the models to illustrate the correlation between uncertainty and companies' cash holdings both in the pre-crisis and post-crisis periods.

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Annex

Table 5

Variance Inflation Factor Test for Multicollinearity

Variable	VIF
$Cash_{asset}$	1.11
unc_{KSA}	2.52
leverage	1.02
Roa	1.27
mktbv	1.55
rev_{growth}	1.00
re	1.75
$icome_{asset}$	1.11
gdp_{oil}	1.46
gdp_{nonoil}	2.22
gdp_{gov}	1.46
$rule_{law}$	1.48
MEAN VIF	1.53

Source: Authors' Calculation.

Table 6

Fisher-Type Test for Cointegration

```
Fisher-type unit-root test for r
Based on augmented Dickey-Fuller tests
_____________________________________

Ho: All panels contain unit roots           Number of panels       =    177
Ha: At least one panel is stationary        Avg. number of periods =  34.67

AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term:   Not included                  ADF regressions: 0 lags
_____________________________________________________________________________

                              Statistic      p-value
_____________________________________________________________________________

 Inverse chi-squared(342)  P       818.7912       0.0000
 Inverse normal            Z       -12.9913       0.0000
 Inverse logit t(844)      L*      -13.9012       0.0000
 Modified inv. chi-squared Pm       18.2306       0.0000
_____________________________________________________________________________

 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
_____________________________________________________________________________
```

Table 7

Johansen Test for Cointegration

Johansen tests for cointegration

Trend: constant — Number of obs = 74
Sample: 1960q4 - 1979q1 — Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	6	106.59982	.	15.0307*	15.41
1	9	112.34203	0.14375	3.5462	3.76
2	10	114.11515	0.04679		

Table 8

Hausman Test

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
stdsauu3_ref	7.61e-06	-.0439354	.043943	.
stdlev	-.1015899	.0269752	-.1285651	.0040055
stdreasst	-.0448506	.0529975	-.0978481	.

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 755.23
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)