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Firm Policies and Uncertainty About Risk

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Abstract: This study examines how firm-specific financial policies and external factors influence the volatility of implied volatility (VOV), a measure of uncertainty about future risks. Using a sample of 6023 firms from January 2000 to December 2022, we derive VOV measures from IvyDB OptionMetrics and employ high-dynamic fixed-effect (HDFE) regressions to analyze the relationship between corporate debt ratios, working capital financing policies (WCFPs), and investor sentiment. Our findings reveal that aggressive debt policies increase VOV, while moderate WCFPs generate the highest uncertainty, indicating investor ambiguity regarding indecisive strategies. Additionally, high sentiment amplifies the effect of debt ratios on VOV, whereas moderate sentiment drives the influence of WCFPs. Industry dynamics, particularly in sectors like finance and manufacturing, further contribute to variations in VOV.

Keywords: debt policy; working capital; risk uncertainty; sentiment; corporate finance

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1. Introduction

Uncertainty is the shadow cast by risk. While traditional measures like volatility and beta offer glimpses into a firm's risk profile, they often fail to capture the more elusive second-order uncertainty: the volatility of implied volatility (VOV). This metric, representing market ambiguity about a firm's future risk trajectory, is pivotal in shaping investor confidence, influencing market dynamics, and determining firm valuation. High levels of VOV indicate greater investor uncertainty, which can drive higher risk premiums, suppress asset prices, and destabilize markets (Baltussen et al., 2018; Cao & Han, 2013).

This study investigates how firm-specific financial policies, alongside broader market and industry conditions, influence VOV. Researchers have uncovered relationships with important implications for stock prices by using option-implied volatility as a proxy for the market-implied expected risk of future stock returns.[1] This naturally raises questions about how firm decisions impact volatility. For example, prior studies have examined the impact of dividend policy on share price volatility (Baskin, 1989; Hussainey et al., 2011). In addition, corporate governance (Li et al., 2013; Aloui & Jarboui, 2018) studies demonstrate that corporate decisions do have an impact on stock return volatility. Research suggests that firm decisions can also play a role, influencing implied volatility shapes (smiles and smirks) and causing more parallel shifts in the volatility moneyness structure (Copeland et al., 2000; Kim & Zhang, 2014).

Furthermore, stock option characteristics have also been shown to have a leading relationship with stock returns and volatilities. An et al. (2014) find that stocks with significant increases in call-implied volatilities tend to exhibit higher future returns. Bali and Hovakimian (2009) demonstrate that deviations in a stock's realized volatility from the implied volatility of stock options predict variations in stock returns. Similarly, Cremers and Weinbaum (2010) argue that deviations from put-call parity (as measured by the difference between call and put implied volatilities) provide information about future stock returns.

Building on these ideas, more recent studies use option information to measure the impact of risk uncertainty on corporate and market behavior. These include research on risk ambiguity's impact on future returns (Baltussen et al., 2018), corporate decision making (Halov et al., 2009), trading activity (Baltussen et al., 2018), and market volatility (Huang et al., 2019). These studies provide valuable insights into how risk uncertainty diminishes returns, reduces optimal debt ratios, and influences market-wide indexes. However, few studies examine how the volatility of risk can be influenced by external forces or corporate behavior itself. This study aims to contribute to this literature by investigating the internal and external factors that affect uncertainty about risk.

Our findings indicate that corporate financing policies significantly impact risk uncertainty in financial markets. While aggressive financial policies increase uncertainty compared to conservative approaches, firms with moderate working capital financing policies (WCFPs) exhibit the highest VOV. This suggests that ambiguity surrounding financial decision making leads to greater investor disagreement. Moreover, we find that higher debt ratios generally amplify risk uncertainty, except when combined with an aggressive WCFP, which mitigates the effect. Additionally, market sentiment plays a crucial role in shaping these relationships—high sentiment strengthens the link between debt ratios and VOV, while moderate sentiment intensifies the uncertainty associated with WCFPs. Industry characteristics further contribute to risk uncertainty, particularly in sectors like finance and manufacturing, which are more sensitive to systemic market fluctuations.

Our findings hold particular relevance for corporate finance managers, who must navigate the implications of their policies on investor perceptions, and for investors, who seek to assess future risks with greater accuracy. By highlighting how financial policies and market sentiment shape uncertainty about risk, this study equips finance managers with insights into optimizing capital structure decisions to mitigate risk ambiguity. Investors, including institutional asset managers and analysts, can use our findings to better understand the informational content embedded in implied volatility movements and refine their risk assessment models. Policymakers and regulators may benefit from understanding how systemic factors contribute to market-wide uncertainty, which could inform regulatory frameworks aimed at stabilizing financial markets.

The remainder of this paper is organized as follows: Section 2 develops the theoretical framework and hypotheses. Section 3 describes the data sources, variable construction, and methodology used to estimate VOV. Section 4 presents the empirical results, while Section 5 discusses the implications of the regression analysis. Finally, Section 6 concludes by summarizing key insights and potential avenues for future research.

2. Hypothesis Development

Financial theory offers a robust framework for examining the relationship between corporate policies and VOV. For instance, an aggressive WCFP—characterized by high reliance on short-term debt to finance long-term assets or permanent working capital—exposes firms to refinancing risks and interest rate volatility (Cheng & Milbradt, 2012). This dynamic amplifies financial distress risks (Admati & Hellwig, 2013; Della Seta et al., 2020) and may lead to greater uncertainty for investors attempting to assess future obligations.

In contrast, firms leveraging long-term debt and equity are more resilient, maintaining solvency under varying financial conditions (Gryglewicz, 2011; Hugonnier & Morellec, 2017). The choice between an aggressive debt policy (characterized by high reliance on short-term borrowing) and a conservative approach (emphasizing stable long-term financing) directly impacts a firm's risk exposure and associated stock price volatility. We, thus, hypothesize that aggressive (conservative) debt strategies amplify (reduce) uncertainty about future risk, as reflected in increased (decreased) VOV.

However, it may also be the case that while an aggressive WCFP increases risk, the risks are well-known, and the market has formed a consensus on them. Conversely, firms that do not adopt a clear policy on working capital financing may be perceived as indecisive or opportunistic by investors. Such firms are more likely to shift their policies inadvertently or drift without commitment, leading to greater disagreement among investors about the firm's risk trajectory. Thus, while risk may increase with an aggressive policy, risk uncertainty could decline. A similar dynamic may exist for firms adopting conservative policies, meaning moderate policies may face greater risk ambiguity. This leads to our second hypothesis that moderate working capital financing policies will lead to higher VOV relative to decisive policies.

According to Merton (1974), firms with higher debt ratios experience greater earnings volatility due to financial leverage, making it more difficult for investors to assess future risks. This uncertainty is particularly pronounced when firms take on excessive debt without a clear long-term financing strategy, as investors struggle to gauge the firm's ability to service its obligations in different economic conditions. As a result, we propose our third hypothesis that firms with higher debt exposure will exhibit greater uncertainty about future volatility.

At the macroeconomic level, market sentiment and industry characteristics also play a vital role in shaping VOV. Investor sentiment reflects the divergence in expectations about asset prices among market participants (Brown & Cliff, 2004), stemming from behavioral tendencies that influence risk perception (Baker & Wurgler, 2006). These differences in outlook influence trading behavior, with sentiment-driven investors making decisions that collectively impact asset price movements. Evidence from Lee et al. (2002) underscores that sentiment plays a critical role in shaping market volatility, with strong variations in sentiment often corresponding to heightened volatility. This creates a market environment where risk becomes harder to assess. Thus, our fourth hypothesis is that greater risk uncertainty occurs during moderate periods of sentiment, as variations in investor optimism generate uncertainty about future risk perceptions and their stability over time.

3. Data and Methodology

3.1. Data Sources and Filtering

We derive VOV measures from the IvyDB OptionMetrics database. Following prior literature (Baltussen et al., 2018; Cremers & Weinbaum, 2010), we filter out options with a stock price below \$5, missing or zero open interest, or missing implied volatility values. We further only use options that are nearest to the money, selecting pairs that have deltas with an absolute value between 0.30 and 0.70, and selecting the pairs that have deltas closest to 0.50 in the case of duplicates. Financial statement information from firms is sourced from Compustat, from which firms' debt ratios and working capital financing policies are measured each quarter. We assign industry codes using the first two digits of the North American Industry Classification System (NAICS) to categorize firms. Sentiment data is derived from the Baker and Wurgler (2006, 2007) index, available from Jeffrey Wurgler's website at the New York University Stern School of Business. These data are reported at a monthly frequency. For our analysis, we use the SENT_ORTH variable, which represents the orthogonalized sentiment measure accounting for macroeconomic effects. However, we replace SENT_ORTH with the SENT variable for the period from March 2021 to July 2021 due to anomalies caused by the orthogonalization methodology. Outside of this specific period, SENT_ORTH closely track SENT and serve as our primary sentiment measure. After applying these filters, our final sample consists of 6023 firms spanning from January 2000 to December 2022.

3.2. Main Variables

3.2.1. Volatility of Volatility

The volatility of equity option-implied volatility (VOV) refers to the variability in the implied volatility derived from options prices. Implied volatility (IV) is derived from the market price of a stock option and represents the market's expectations of the stock's volatility over the life of the option. Unlike historical volatility, which looks at past price movements, IV is forward-looking and reflects anticipated volatility during the lifespan of the option. Our analysis utilizes IV as a proxy for investor expectations. By tracking changes in IV, we can infer how external events or internal corporate actions are perceived by the market, potentially influencing stock behavior. Therefore, VOV measures the uncertainty or the volatility of this expectation. It is a second-order gauge of uncertainty in the market, capturing not just how much stock prices are expected to move, but how uncertain those expectations are. This study examines VOV as a crucial indicator of market sentiment, particularly how it responds to different corporate financial policies. High VOV indicates greater uncertainty among investors about future price movements of a stock, which can be influenced by forces from industry, market sentiment, and corporate decisions.

To measure risk ambiguity, we calculate VOV by scaling monthly standard deviations of implied volatility by the average implied volatility for the month (a minimum of 12 observations), similar to Baltussen et al. (2018). Since changes in implied volatility are typically larger for stocks with higher volatility in their returns, our measure ensures that uncertainty about risk is comparable across stocks with different levels of expected risk.

$$VOV_{i,M} = \frac{\sqrt{\frac{1}{D}\sum\left(\sigma_{i,d}^{IV} - \overline{\sigma}_{i,M}^{IV}\right)^2}}{\overline{\sigma}_{i,M}^{IV}} \tag{1}$$

where $VOV_{i,M}$ is the VOV measure at the end of a given month, D is the trading day observed in the month, and $\overline{\sigma}_{i,M}^{IV}$ is the average monthly implied volatility. Option data was taken from the OptionMetrics database during the period from January 2000 to December 2022. We use only options closest to the money in the implied volatility measures to avoid results that may be driven by moneyness and further filter out observations that have an absolute value of delta outside the range of 0.25 and 0.75. To avoid the effects of time to expiration, we exclude options that are less than 20 days or greater than 60 days from expiration or have an underlying stock price below 5 dollars at the end of the month. In situations where two options are available, we chose the option that is closer to having 30 days remaining until expiration.

3.2.2. Debt Policy Measures

Firm-level independent variables are tested to explain VOV derived from the debt policies used by individual firms, specifically the debt ratio (DR) and a firm's working capital financing policy (WCFP). Since increased debt leads to more risk in firm cash flows and stock returns due to the financial leverage that debt provides, changes in earnings become amplified by the economic environment. This risk can be exacerbated with the use of short-term financing. Firms that take more aggressive stances on current account financing may utilize short-term borrowing, even for permanent current asset levels. Borrowing short on assets or asset levels that are viewed as long-term is a risky proposition, as sudden increases in interest rates can cause corresponding increases in financing costs, leading to difficulty in making payments on maturing short-term debt.

DR is calculated by taking total debt divided by total assets, a measure sourced directly from the Compustat dataset. To account for industry influence, we calculate the difference between a firm's debt ratio and the mean industry debt ratio. Following the methodology of Addin Al-Mawsheki (2022), we calculate a firm's WCFP by taking the difference between its temporary working capital and its short-term debt, divided by the firm's working capital. We define temporary working capital as the sum of the differences between the firm's observed cash, inventory, and receivables and their permanent levels, which are measured as the minimum levels for the past two calendar years, exclusive. The difference from the industry mean is also calculated for WCFP.

3.2.3. Investor Sentiment

For our measure of sentiment, we use the composite index developed by Baker and Wurgler (2006, 2007), henceforth referred to as BW. This index is constructed using the first principal component of six investor sentiment measures, orthogonalized against six macroeconomic variables. The orthogonalization process filters out idiosyncratic noise from the individual sentiment measures and removes the influence of broader economic conditions. The six sentiment measures include the closed-end fund discount, the number and first-day returns of IPOs, NYSE turnover, the equity share in total new issues, and the dividend premium. The macroeconomic variables used for orthogonalization are employment growth, industrial production growth, real growth in durable consumption, nondurable consumption, and service consumption, as well as the recession indicator provided by the National Bureau of Economic Research. BW captures the residual component of sentiment that reflects behavioral biases and is not explained by the state of the economy. Since its inception, BW's sentiment indicator has been widely adopted in financial and economic research.[2]

3.3. Summary Statistics

Table 1 presents annual distribution statistics for VOV, DR, and WCFP from 2000 to 2022, computed using straight annual averages. The data suggest an upward trend in VOV over time, rising from an average of 0.117 in 2000 to 0.215 in 2022. This increase may be attributed to the expansion of options markets as they became more developed, including the introduction of options on equities with higher realized volatilities, such as small-cap and lower-priced stocks. This trend persists despite the metric's scaling adjustments. The Augmented Dickey–Fuller test on monthly averages of VOV rejects the null hypothesis at the 1% level, confirming that VOV is stationary. Debt ratios are relatively stable, although spikes are observed during periods of economic crises, such as the 2008 financial crisis and the pandemic-induced economic shutdowns in 2020. Most firms adopt a conservative working capital financing policy, as indicated by consistently positive averages over the sample period.

Figure 1 illustrates the monthly time series of VOV and BW from January 2000 to December 2022, with the right y-axis measuring BW levels. Despite efforts to orthogonalize broader economic effects, BW continues to exhibit cyclical patterns, reflecting its nature as a behavioral trait. It rises and falls with the economic cycle but remains persistently elevated after events that precipitate economic fluctuations. This pattern is evident in the build-up and subsequent decline during the dot-com bubble, the housing and financial crises, and the stimulus-driven trading exuberance following the COVID-19 pandemic.

Table 1. Descriptive summary of the vol-of-vol (VOV), debt ratio (DR), and working capital financing policy (WCFP) over the sample period from January 2000 to December 2022. VOV is calculated as the past month's standard deviation of option-implied volatility (IV), standardized by average IV. DR is calculated by taking the firm's total debt divided by total assets. WCFP is estimated by dividing the difference between temporary working capital and short-term debt by total working capital.

Year	VOV	VOV(SD)	VOV(Med)	DR	DR(SD)	WCFP	WCFP(SD)
2000	0.106	0.107	0.073	0.470	1.007	0.240	1.243
2001	0.118	0.125	0.079	0.419	0.873	0.220	1.238
2002	0.133	0.135	0.089	0.437	0.917	0.198	1.202
2003	0.134	0.137	0.091	0.489	1.047	0.208	1.179
2004	0.128	0.133	0.085	0.379	0.907	0.209	1.142
2005	0.146	0.155	0.093	0.353	0.894	0.224	1.141
2006	0.129	0.128	0.090	0.368	0.945	0.210	1.136
2007	0.129	0.120	0.094	0.397	1.054	0.212	1.083
2008	0.138	0.121	0.106	0.534	1.216	0.211	1.227
2009	0.123	0.121	0.088	0.597	1.169	0.172	1.156
2010	0.142	0.142	0.096	0.466	0.985	0.185	1.071
2011	0.167	0.163	0.109	0.436	0.919	0.170	1.135
2012	0.184	0.184	0.114	0.465	0.956	0.164	1.139
2013	0.175	0.178	0.109	0.421	0.891	0.159	1.131
2014	0.192	0.179	0.128	0.389	0.841	0.158	1.125
2015	0.198	0.188	0.127	0.448	0.961	0.167	1.136
2016	0.195	0.181	0.129	0.519	1.089	0.183	1.195
2017	0.178	0.173	0.119	0.449	0.951	0.166	1.211
2018	0.193	0.171	0.136	0.434	0.859	0.188	1.162
2019	0.176	0.165	0.120	0.543	1.005	0.165	1.235
2020	0.197	0.164	0.141	0.668	1.218	0.212	1.200
2021	0.173	0.161	0.120	0.416	0.830	0.195	1.099
2022	0.196	0.150	0.150	0.413	0.818	0.111	1.166

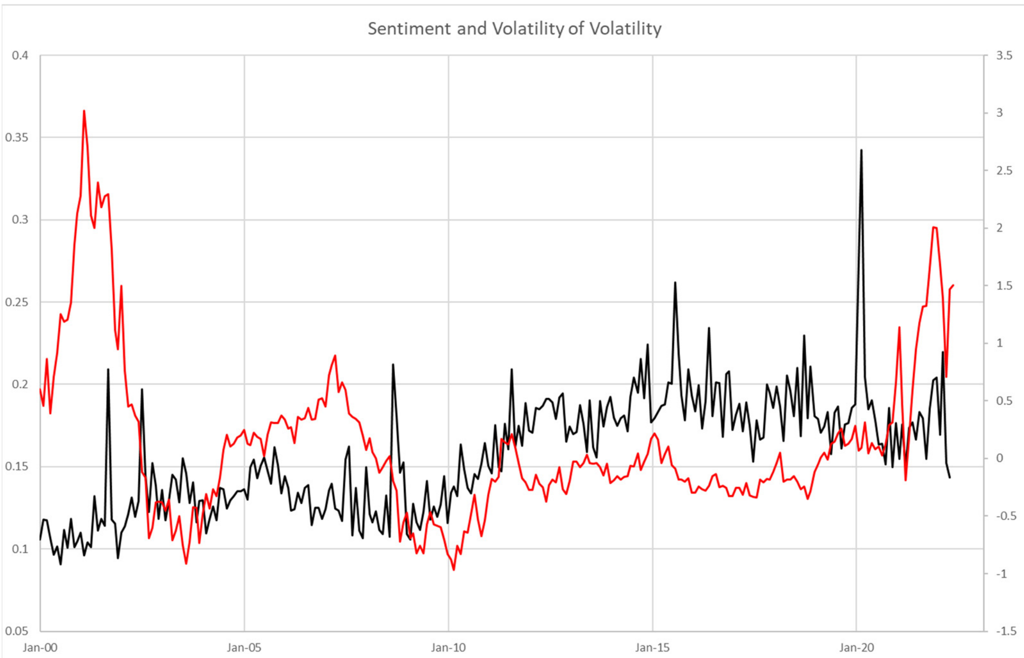

Figure 1. Monthly VOV (in black) and BW sentiment (in red).

However, sentiment does not always track the market directly. For instance, sentiment levels remained mediocre from approximately 2011 to 2019 despite strong market growth during this period. Notably, VOV levels during this era were higher than in the preceding decade, supporting the notion that VOV serves as a reasonable proxy for risk uncertainty. When market participants share a stronger consensus on sentiment—whether optimistic or pessimistic—it stands to reason that they also develop a clearer consensus on future risks irrespective of the validity of their aggregate view. Conversely, in the absence of a directional consensus on sentiment, competing individual sentiments may amplify uncertainty in risk forecasts.

A particularly striking observation is the contrast between the "stickiness" of BW and the more stationary VOV, characterized by brief but pronounced spikes. Theoretically, it is implausible for BW to lead VOV, as VOV reflects forward-looking expectations for forward-looking assets, while BW is more coincident or even lagging relative to the business cycle. Nonetheless, significant spikes in VOV above local means often occur during periods of declining sentiment. This suggests that VOV is influenced by investor fear, especially when such fear follows more optimistic outlooks. The dramatic spike in VOV during the early stages of the COVID-19 pandemic, coinciding with the escalating news coverage and subsequent economic shutdowns, supports this interpretation. Interestingly, this occurred before the economic effects of the pandemic were fully realized or recorded.

Finally, Figure 1 raises questions about VOV's characterization as a forward-looking measure. While VOV's spikes indicate a reactionary response to economic shocks—consistent with the notion that such shocks increase uncertainty about future risks—these episodes of risk ambiguity are notably short-lived. This suggests that either investors are highly efficient at recalibrating their risk expectations or that VOV is predominantly a reactionary measure, closely tied to market volatility.

To examine this, we run simple OLS regressions of the volatility of stock volatility on lagged values of VOV, using the following formula:

$$VOV_{VW,t} = \alpha + \beta_1 VOV_{t-1} + \epsilon_t \tag{2}$$

where $\mathrm{VOV_{VW}}$ is the volatility of the standard deviation of daily market returns measured at the end of each month t and $\mathrm{VOV_{t-1}}$ is the mean volatility of option-implied volatility measured in the previous month. We also include control variables such as the lag of $\mathrm{VOV_{VW}}$, and lagged measures of market return volatility (VWSD). We use the value-weighted index provided by the Center for Research in Security Prices (CRSP) to begin with market returns. VWSD is calculated by taking the standard deviations of returns for the given month, and $\mathrm{VOV_{VW}}$ is created using the past 21 trading days to estimate the standard deviation of returns for each day of the month, and then the standard deviation of that measure is calculated to estimate the volatility of market volatility for the given month.

The results, omitted for brevity, show that past measures of option-level VOV significantly and positively correlate with equity-level $\mathrm{VOV_{VW}}$ across all three regressions. The coefficient on $\mathrm{VOV_{t-1}}$ remains positive and significant after including lagged values of the dependent variable and past measures of market return volatility, with a *t*-statistic of 4.67. Neither past measures of $\mathrm{VOV_{VW}}$ nor VWSD show a significant relationship when included, suggesting that past risk uncertainty in options markets is a superior predictor of future risk uncertainty in equity markets. Furthermore, we examine whether lagged values of VWSD and $\mathrm{VOV_{VW}}$ explain current levels of VOV and find no positive relationship. In fact, the coefficient on lagged VWSD is significant and negative, indicating option traders are adept at shrugging off past market return volatility to form new expectations on risk, but in equity markets, such risk uncertainty continues to persist. While reactionary to economic and geopolitical shocks, option-level VOV serves as a strong predictor of observed risk uncertainty in the equity markets.

4. Empirical Results

Table 2 presents the mean VOV measures at the intersection of independently sorted quintiles of firms' debt ratios and working capital financing policies, including lagged and future VOV measures. For working capital, the lowest quintile indicates an aggressive policy, while the highest quintile reflects a conservative policy for financing current assets. Across all forward periods, higher VOV measures are observed when firms adopt more aggressive working capital policies. This effect is most pronounced when debt ratios are not in the highest quintiles. However, the highest VOV values tend to occur when WCFP is moderate, specifically in the third quintile. This relationship holds across all debt ratio quintiles, with the highest VOV values observed when long-term leverage is high and WCFP is moderate. This finding indicates that firms with moderate policies may be perceived by investors as either indecisive or opportunistic. Supporting this, additional analysis reveals that a larger number of firms tend to move out of the third quintile over time. Furthermore, firms in the third quintile are 40% more likely to experience policy drift over the next twelve months compared to firms with aggressive policies and 30% more likely than those with conservative policies. This suggests that committing to neither conservative nor aggressive working capital policies could send mixed signals to the market as they attempt to gauge the future trajectory of the firm's policies, leading to disagreement among investors.

The difference in VOV between high and low debt ratios is consistently positive across all WCFP quintiles except for the most aggressive. While higher debt ratios generally lead to higher VOV, this effect can be offset by an aggressive policy on financing current assets. Thus, it is not necessarily aggressive financing itself that drives higher risk ambiguity compared to conservative financing, but rather an overreliance on short-term debt when leverage needs are low, which exacerbates uncertainty about risk. Regardless, the group with the lowest VOV consists of firms with debt ratios near the industry average. Overall, the results indicate that adopting a clear policy on financing current assets can reduce risk uncertainty in the market, and that it can be further reduced when that policy is more conservative in nature. The lowest VOV occurs for firms in the intersection of the most conservative WCFP and a DR near the industry average. The highest VOV occurs for the most leveraged firms with the highest DR.

To test against endogeneity, Table 2 also examines lagged observations of VOV. While the directional relationships persist, much of the magnitudes and significance of deviations in VOV are diminished. Firms that have high debt ratios and aggressive short-term financing in the current period were likely to have similar measures in the recent past, but the decline in magnitude and significance captures the presence of firms that may have recently restructured their financing policies. The further back the VOV is observed, the smaller the effects of debt policy appear.

In Table 3, we conduct the same procedure as Table 2 for different levels of sentiment. Sentiment is sorted as low, moderate, or high, with breakpoints at the 25th and 75th percentiles of the distribution during the sample period. The results suggest that sentiment also significantly influences the relationship between debt policy and VOV. Displaying VOV only three months forward for brevity, we determine that total debt exerts a stronger influence during periods of high sentiment. However, this influence remains positive even when working capital financing is aggressive, in contrast to Table 2. The effect of aggressive WCFP is strongest when sentiment is in the moderate range. In fact, moderate sentiment is associated with higher VOV levels in general, conforming to our earlier supposition that high or low sentiment reduces risk uncertainty and that such ambiguity is positively correlated with market-level ambiguity in sentiment.

Table 2. This table reports mean future vol-of-vol (VOV) measures at the intersection of quintile sorts for a firm's working capital financing policy (WCFP) and its debt ratio (DR). The VOV measures are reported 3 and 6 months following and prior to quintile formation. VOV is calculated as the past month's standard deviation of option-implied volatility (IV), standardized by average IV. WCFP is measured as the difference between temporary working capital and short-term debt divided by working capital. t-statistics are shown in bold.

6 Months Lagged							
		Aggressive		WCFP	Conservative		Con-Agg
		1	2	3	4	5	
Debt Ratio	1	0.1518	0.1518	0.1585	0.1503	0.1476	−0.0042
							−2.45
	2	0.1478	0.1524	0.1564	0.1512	0.1455	−0.0023
							−1.24
	3	0.1373	0.1434	0.1458	0.1402	0.1354	−0.0019
							−1.18
	4	0.1419	0.1515	0.1519	0.1450	0.1401	−0.0017
							−1.15
	5	0.1458	0.1535	0.1623	0.1528	0.1466	0.0008
							0.50
	High–Low	−0.0060	0.0018	0.0037	0.0025	−0.0010	
		−3.76	**0.90**	**1.70**	**1.35**	**−0.63**	

3 Months Lagged							
		Aggressive		WCFP	Conservative		Con-Agg
		1	2	3	4	5	
Debt Ratio	1	0.1532	0.1559	0.1608	0.1548	0.1479	−0.0053
							−3.14
	2	0.1514	0.1526	0.1583	0.1502	0.1421	−0.0093
							−5.12
	3	0.1379	0.1452	0.1463	0.1379	0.1350	−0.0028
							−1.79
	4	0.1418	0.1522	0.1537	0.1436	0.1414	−0.0004
							−0.29
	5	0.1471	0.1574	0.1645	0.1551	0.1471	0.0001
							0.04
	High–Low	−0.0061	0.0015	0.0037	0.0003	−0.0008	
		−3.86	**0.76**	**1.73**	**0.17**	**−0.48**	

3 Months Forward							
		Aggressive		WCFP	Conservative		Con-Agg
		1	2	3	4	5	
Debt Ratio	1	0.1568	0.1541	0.1579	0.1535	0.1471	−0.0097
							−5.86
	2	0.1538	0.1551	0.1615	0.1545	0.1415	−0.0122
							−7.12
	3	0.1425	0.1503	0.1535	0.1449	0.1365	−0.0060
							−3.87
	4	0.1465	0.1571	0.1604	0.1502	0.1436	−0.0029
							−1.93
	5	0.1507	0.1643	0.1702	0.1612	0.1525	0.0018
							1.16
	High–Low	−0.0061	0.0102	0.0123	0.0077	0.0054	
		−3.85	**5.05**	**5.69**	**4.13**	**3.38**	

6 Months Forward							
		Aggressive		WCFP	Conservative		Con-Agg
		1	2	3	4	5	
Debt Ratio	1	0.1535	0.1547	0.1594	0.1526	0.1467	−0.0067
							−4.07
	2	0.1523	0.1573	0.1612	0.1544	0.1429	−0.0094
							−5.36
	3	0.1434	0.1521	0.1535	0.1431	0.1369	−0.0065
							−4.03
	4	0.1471	0.1572	0.1606	0.1491	0.1427	−0.0044
							−2.96
	5	0.1503	0.1622	0.1699	0.1592	0.1509	0.0007
							0.44
	High–Low	−0.0032	0.0075	0.0105	0.0066	0.0042	
		−2.00	**3.70**	**4.82**	**3.45**	**2.63**	

Table 3. This table reports mean future vol-of-vol (VOV) measures at the intersection of quintile sort for a firm's working capital financing policy (WCFP) and its debt ratio (DR) during different levels of BW sentiment. The VOV measures are reported 3 months following and prior to quintile formation. VOV is calculated as the past month's standard deviation of option-implied volatility (IV), standardized by average IV. WCFP is measured as the difference between temporary working capital and short-term debt divided by working capital. To categorize market sentiment, we sort the monthly BW sentiment index into quartiles. Low sentiment corresponds to observations below the 25th percentile, while high sentiment refers to observations above the 75th percentile. t-statistics are shown in bold.

		Aggressive		WCFP	Conservative		Con-Agg
		1	**2**	**3**	**4**	**5**	
Low Sentiment							
Debt Ratio	1	0.1280	0.1259	0.1284	0.1285	0.1277	−0.0003
							−0.08
	2	0.1217	0.1298	0.1276	0.1230	0.1244	0.0027
							0.62
	3	0.1336	0.1326	0.1307	0.1221	0.1110	−0.0226
							−4.84
	4	0.1291	0.1318	0.1262	0.1295	0.1266	−0.0025
							−0.61
	5	0.1306	0.1302	0.1300	0.1362	0.1328	0.0023
							0.58
	High–Low	0.0025	0.0044	0.0016	0.0077	0.0051	
		0.66	**1.03**	**0.35**	**1.82**	**1.39**	
Mid Sentiment							
		Aggressive		**WCFP**	**Conservative**		**Con-Agg**
		1	**2**	**3**	**4**	**5**	
Debt Ratio	1	0.1626	0.1636	0.1706	0.1641	0.1542	−0.0084
							−4.15
	2	0.1605	0.1658	0.1737	0.1667	0.1508	−0.0097
							−4.58
	3	0.1504	0.1578	0.1583	0.1484	0.1423	−0.0081
							−4.24
	4	0.1518	0.1618	0.1665	0.1543	0.1463	−0.0055
							−3.08
	5	0.1538	0.1691	0.1777	0.1642	0.1555	0.0017
							0.90
	High–Low	-0.0088	0.0055	0.0071	0.0001	0.0012	
		-4.60	**2.27**	**2.70**	**0.04**	**0.63**	
High Sentiment							
		Aggressive		**WCFP**	**Conservative**		**Con-Agg**
		1	**2**	**3**	**4**	**5**	
Debt Ratio	1	0.1245	0.1221	0.1171	0.1217	0.1267	0.0022
							0.50
	2	0.1256	0.1287	0.1237	0.1186	0.1193	−0.0063
							−1.50
	3	0.1142	0.1273	0.1254	0.1230	0.1145	0.0003
							0.08
	4	0.1269	0.1378	0.1295	0.1274	0.1227	−0.0042
							−1.09
	5	0.1496	0.1486	0.1552	0.1525	0.1409	−0.0087
							−1.86
	High–Low	0.0251	0.0265	0.0381	0.0308	0.0142	
		5.33	**4.34**	**5.49**	**5.19**	**3.05**	

The above tests provide evidence that uncertainty about risk can increase due to an overreliance on short-term debt in corporate financing decisions. Investors' added uncertainty regarding future short-term rate movements is likely a key driver of this finding. In addition to the ordinary ambiguity of future risk, such firms also face the added risks associated with short-term financing, namely the possibility of higher rates and increased interest costs. Simultaneously financing long-term debt at sufficient levels mitigates this risk of interest cost uncertainty, as a larger proportion of the firm's interest costs are fixed. Thus, an increase in short rates would not cause as much volatility in financing expenses as it would for a firm that primarily relies on short-term financing.

To further test the idea that an overreliance on short-term debt can increase risk uncertainty, Figure 2 provides the results of an event study that plots the change in VOV following a move to one of the extreme quintiles of debt ratio or short-term financing. The four graphs, from top to bottom, are labeled "Working Capital to Aggressive", "Working Capital to Conservative", "Debt Ratio to Low", and "Debt Ratio to High". "WC to Aggressive" measures the change in VOV over the next 12 months following a shift from a less aggressive quintile to the most aggressive quintile. The dotted lines represent the 95% confidence intervals of the VOV changes. VOV increases following a shift in policy, whether it involves a change to a more aggressive short-term financing policy or a more conservative one. VOV also increases following restructuring to a higher overall debt ratio. Moving to the lowest debt quintile does not produce a significant change in VOV over the following year. Figure 2 demonstrates that a shift in financing policy can cause a temporary increase in risk uncertainty as investors assess the new financial structure of the firm.

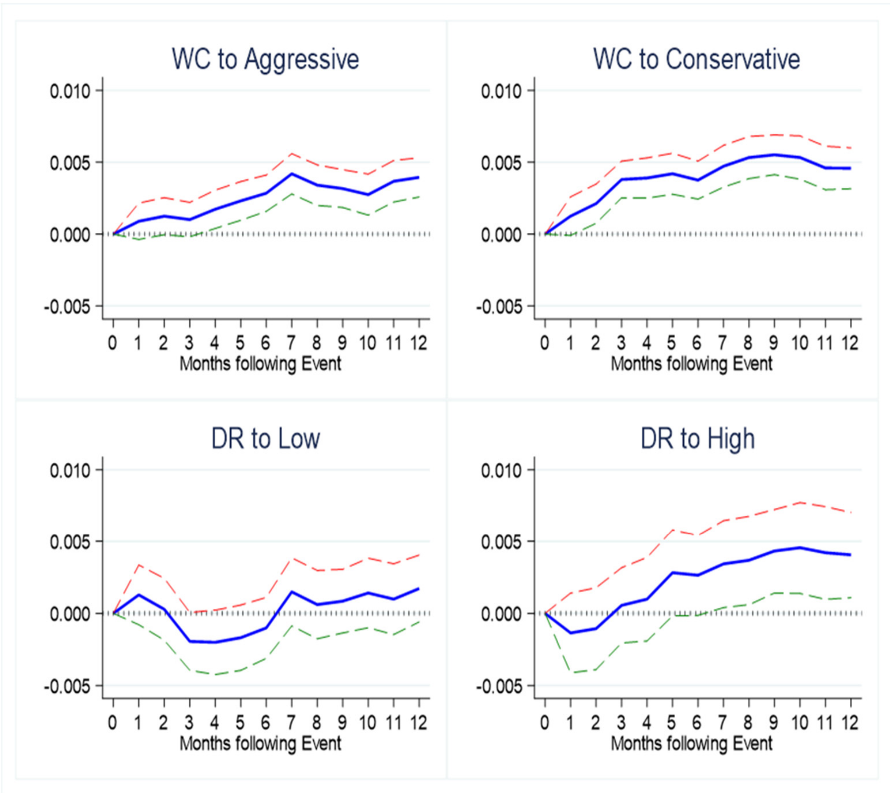

Figure 2. The dotted lines represent the 95% confidence intervals of the VOV changes.

5. Regression Analysis

Before beginning regression analysis, we examine the dispersion of VOV among the various industries classified under the 22 categories defined by the North American Industry Classification System (NAICS). Campbell et al. (2001) examine industry-level and firm-level variances and find that industry-level variance is relatively stable, while idiosyncratic volatility of firms increased over the latter part of the 20th century. A key implication of this finding is that although market and industry volatility has not increased, the level of uncertainty among individual firms has been rising.

However, industry-level volatility can affect both market volatility and exhibit a causal relationship within various industries (Wang, 2010). Furthermore, industries have been shown to have differing long-run trends and averages in volatility, with some industries (e.g., finance) being more influential in causing market-wide volatility and impacting future GDP. Despite aggregate stability, trends among specific industry-level volatilities can still emerge, as more than half the industries were found to exhibit increasing volatilities. Chiu et al. (2015) demonstrate that the tail risk of financial firms can spill over into real sectors, a phenomenon exacerbated during periods of economic crisis, particularly in competitive industries.

Table 4 presents the descriptive VOV statistics among industries and highlights significant differences between them. Warehousing firms, on average, have much lower observed VOV measures than finance and real estate firms. However, variation within industries is noticeable, with high standard deviations and ranges large enough to overlap the extreme ends of the VOV spectrum. All industry VOV measures are also positively skewed with high kurtosis, reflecting the tendency to observe upward spikes in the historical data.

Table 4. This table provides distribution statistics of VOV for 22 industries using the North American Industry Classification System. VOV is calculated monthly by calculating the standard deviation of daily option-implied volatility (IV), standardized by the average IV. The sample consists of data from January 2000 to December 2022.

Industry	VOV	SD	P25	P50	P75	SKEW	KURT
Warehousing	0.0989	0.0540	0.0612	0.0888	0.1242	1.9	9.6
Mining/Oil Gas	0.1109	0.1121	0.0552	0.0788	0.1157	3.7	20.9
Retail (Online)	0.1287	0.1200	0.0624	0.0937	0.1469	3.3	17.6
Retail (Brick and Mortar)	0.1336	0.1230	0.0639	0.0972	0.1537	3.3	18.1
Hospitality and Food	0.1408	0.1354	0.0658	0.0988	0.1552	3.3	18.2
Manufacturing (Food)	0.1414	0.1326	0.0666	0.1015	0.1590	3.2	16.8
Transportation	0.1466	0.1443	0.0654	0.0975	0.1584	2.8	13.4
Manufacturing (Raw Material)	0.1512	0.1418	0.0683	0.1036	0.1718	2.8	14.4
HealthCare	0.1519	0.1446	0.0703	0.1057	0.1681	2.9	14.7
Manufacturing (Metals)	0.1528	0.1487	0.0674	0.1031	0.1711	2.8	13.6
Information	0.1565	0.1515	0.0686	0.1071	0.1776	2.8	13.8
Construction	0.1584	0.1623	0.0644	0.0986	0.1774	2.6	11.3
Arts and Entertainment	0.1589	0.1618	0.0674	0.1018	0.1762	2.8	13.8
Wholesale	0.1613	0.1515	0.0707	0.1095	0.1863	2.6	12.2
Education	0.1661	0.1531	0.0735	0.1157	0.1991	2.7	13.4
Real Estate	0.1689	0.1575	0.0742	0.1142	0.1979	2.6	11.7
STEM	0.1701	0.1631	0.0717	0.1134	0.1976	2.5	11.0
Agriculture	0.1782	0.1806	0.0721	0.1107	0.2048	2.5	10.6
Administrative	0.1889	0.1758	0.0768	0.1260	0.2308	2.2	9.5
Utilities	0.2079	0.1959	0.0790	0.1314	0.2683	2.1	8.8
Finance and Insurance	0.2083	0.1998	0.0777	0.1285	0.2661	2.0	8.2
Other Services	0.2163	0.2050	0.0879	0.1422	0.2702	2.6	13.4

In untabulated results, we also measure the correlation of industry-level VOV with market levels and the correlation between industries. Notably, the Finance and Insurance and Metal Manufacturing industries exhibit the highest average correlation with market VOV (0.70 and 0.73) and the highest correlation between any two pairs (0.91). This aligns with Wang's (2010) finding regarding the impact of the finance industry on volatility. The finance industry also shows particularly high correlations with individual industries requiring significant research costs, such as the STEM industry (0.84) and industries that utilize a high component of real assets, including Construction (0.82), Raw Materials (0.84), and Wholesale (0.82). Among the industries with the lowest correlations are Warehousing (0.38), Arts and Entertainment (0.41), and "Other Services" (0.24), which include religious and civic organizations, personal services, and other competitive industries typically more associated with small business owners than publicly traded corporations.

The results suggest there are interesting industry dynamics regarding risk uncertainty that merit further examination and testing. They also indicate that a fixed-effects regression model is necessary to account for industry effects.

We run high-dynamic fixed-effect regressions (HDFE) with concurrent and future VOV as the dependent variables and debt ratio, working capital financing ratio, current market volatility (using the CRSP value-weighted index), and BW sentiment as explanatory variables. This approach controls for heterogeneity, heteroscedasticity, and autocorrelation by including industry fixed effects and clustering standard errors at the time and industry levels, thereby eliminating bias from omitted variables that do not vary over time—a primary source of endogeneity. Furthermore, we include lagged dependent variables to address simultaneity and ensure robustness against reverse causality. Weak instrumentation for VOV prevented us from conducting suitable tests using GMM or 2SLS. However, we argue that the panel fixed-effects structure of the HDFE model effectively mitigates endogeneity concerns. We include an indicator variable, MOD, equal to one if the firm is in the third quintile of WCFP to indicate a moderate policy. We also include a dummy variable, BIG, equal to one if the firm's market capitalization is at or above the 80th percentile of the firm size distribution.

Table 5 reports the results. We observe that higher debt ratios are related to higher levels of VOV, and this relationship weakens the further we observe into the future. WCFP, on the other hand, has a consistently negative relationship with future VOV, indicating that more conservative approaches decrease risk ambiguity relative to aggressive policies. In the second model, we include the dummy variable for moderate policies, which are shown to have a positive influence on VOV, demonstrating that an unclear policy (neither aggressive nor conservative) can lead to more risk uncertainty. Meanwhile, large firms, which are also likely to garner more coverage from analysts, reduce risk uncertainty, although their impact is not enough to reduce the significance of the debt policy measures. Interestingly, we also observe a significant negative relationship between past market volatility and future VOV. This implies that past risk is quickly incorporated into estimates of future risk. Large firms with low debt ratios and conservative working capital financing policies, on average, experience lower risk uncertainty, perhaps due to expectations that more robust future earnings will be more reliable in providing the resources to meet short-term obligations.

Table 5. This table reports the regression results analyzing the relationship between future vol-of-vol (VOV) and various financial variables, including a firm's debt ratio (DR), working capital financing policy (WCFP), and the standard deviation of the value-weighted CRSP Index (VWSD). The VOV measures are calculated for 0, 3, and 6 months following the initial measurement period. For each time horizon, the regressions include industry fixed effects to control for unobserved heterogeneity across industries, and standard errors are clustered by both industry and time to ensure robust inference.

Months Forward	0			3			6		
DR	0.643	0.663	0.642	0.480	0.502	0.482	0.401	0.424	0.403
	3.10	3.17	3.03	2.25	2.33	2.21	1.77	1.86	1.75
WCFP	−0.074	−0.070	−0.070	−0.065	−0.061	−0.062	−0.052	−0.048	−0.049
	−2.43	−2.35	−2.37	−1.99	−1.90	−1.94	−1.47	−1.37	−1.43
VWSD	0.424	0.427	0.397	−1.465	−1.462	−1.491	−1.181	−1.177	−1.202
	0.70	0.70	0.68	−3.78	−3.78	−4.03	−4.18	−4.17	−4.46
SENT	−0.873	−0.858	−0.869	−0.722	−0.704	−0.720	−0.772	−0.753	−0.765
	−2.45	−2.42	−2.48	−2.18	−2.14	−2.26	−2.24	−2.20	−2.27
MODERATE		0.929	0.896	0.000	0.992	0.963	0.000	1.022	0.991
		3.83	3.66		5.11	4.96		7.06	6.90
BIG			−1.738	0.000	0.000	−1.768	0.000	0.000	−1.763
			−3.88			−3.89			−3.84
CONST	0.149	0.147	0.160	0.166	0.164	0.178	0.163	0.161	0.174
	25.42	25.12	25.45	38.94	38.66	31.06	48.14	47.92	32.52

6. Conclusions

We find that firms' debt policies play a significant role in shaping VOV. Higher debt ratios are associated with increased uncertainty, as financial leverage amplifies earnings volatility and complicates investors' assessments of firm stability. However, this effect depends on the firm's working capital financing policy. While aggressive WCFPs can increase refinancing risk and thus elevate VOV, we find that the highest levels of VOV actually occur in firms with moderate WCFPs. This suggests that firms without a clear financing strategy create greater ambiguity for investors, as their lack of commitment to a stable financing structure leads to uncertainty about future decisions.

Moreover, we find that market sentiment significantly interacts with corporate financial policies in determining VOV. High sentiment amplifies the positive relationship between debt ratios and VOV, while moderate sentiment conditions intensify the influence of WCFP on VOV. This implies that investor optimism or pessimism shapes how corporate policies are perceived in terms of risk. Overall, periods of moderate sentiment exhibit the highest levels of risk ambiguity, as investors lack a strong directional consensus, leading to heightened uncertainty in risk forecasts.

Finally, industry dynamics further contribute to variations in VOV. Our results indicate that firms operating in highly cyclical or financially sensitive industries experience greater fluctuations in VOV. The Finance and Insurance and Metal Manufacturing industries exhibit the highest average correlation with market VOV, suggesting that industry-wide shocks influence investors' risk perceptions.

While we employ VOV as a proxy for risk uncertainty, alternative measures—such as option skewness, realized volatility, jump risk measures, entropy-based approaches, and hybrid models that combine VOV with other metrics—may capture additional dimensions of risk perception. Future research could compare multiple measures of uncertainty to provide a more comprehensive view of risk ambiguity.

Overall, our findings suggest that corporate financial decisions, market sentiment, and industry conditions collectively shape risk ambiguity in financial markets. Firms can reduce uncertainty by adopting clear and consistent financial policies, while investors should account for sentiment-driven distortions in risk perceptions. By deepening our understanding of the factors influencing VOV, this study provides valuable insights for corporate managers, investors, and policymakers seeking to navigate an increasingly uncertain financial landscape.

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Notes

[1] See Mayhew (1995); Dumas et al. (1998); Britten-Jones and Neuberger (2000); Jiang and Tian (2005); Buss and Vilkov (2012).

[2] In addition to Baker and Wurgler (2006, 2007), see Yu and Yuan (2011), Stambaugh et al. (2012), Antoniou et al. (2013, 2016), and Ashour et al. (2023).

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