Liquidity Determinants of Covered Call Warrants: Empirical Evidence from Vietnam

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Abstract:

Research purpose:

This research is aimed at identifying the key determinants of covered warrant liquidity in the Vietnamese stock market by investigating warrant-specific, market-related, and macroeconomic factors. The study seeks to provide a better understanding of the drivers of liquidity and contribute to the sustainable development of this emerging financial instrument.

Research motivation:

Covered call warrants have recently emerged as a new investment instrument in Vietnam's stock market, playing a crucial role in enhancing market liquidity, providing investors with hedging, diversifying and speculative opportunities. However, the liquidity of covered call warrants is unstable and varies in emerging markets, making it essential to examine its determinants and provide practical implications for issuers, investors, and regulators.

Research design, approach, and method:

This study employs an Ordinary Least Squares (OLS) regression model to analyze the determinants of covered warrant liquidity. The empirical specification is adapted from prior studies on option market liquidity and the dataset is constructed from the full universe of publicly listed and expired covered call warrants within the Vietnamese financial market during June 2019 to January 2025

Main findings:

The empirical results reveal that underlying trading volume and trading period have positive effects on covered warrant liquidity, while market volatility, moneyness, and the risk-free rate exert significant negative impacts. In contrast, the volatility of the underlying asset is not statistically significant.

Practical implication:

Theoretical knowledge – The study contributes to the literature on derivative markets by clarifying how market volatility, moneyness, trading period, and the risk-free rate affect covered warrant liquidity in an emerging market context.

Investment recommendation – The findings provide useful references for investors in managing liquidity risk, for issuers in improving product design, issuance strategies, and for regulators in refining the legal framework to enhance efficiency, support the sustainable development of Vietnam's derivatives market.

Keywords: Covered warrants, Liquidity, Stock volatility, Trading volume, Vietnam.

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1. Introduction

Covered warrants (CWs) first emerged in the late 1980s and early 1990s in Hong Kong and Germany and have since expanded across global markets under different labels, such as Derivatives Warrants (Thailand, Hong Kong), Structured Warrants (Singapore, Malaysia), and Equity-Linked Warrants (South Korea). Issued by financial institutions, CWs provide investors with leveraged exposure to underlying equities at a lower capital outlay than direct stock purchases. Over the past 25 years, the global CW market has developed rapidly, particularly in the Asia–Pacific region, which accounts for approximately 76% of global trading revenue, with Hong Kong and Taiwan serving as major hubs. In Vietnam, CWs were officially introduced on the Ho Chi Minh Stock Exchange (HOSE) in June 2019, marking a strategic step in diversifying financial products. Since then, the market has expanded considerably in both listings and liquidity; by June 2023, 50 new CW codes had been issued, with an average daily trading volume of nearly 19.5 million CWs and an average daily trading value exceeding VND 24.9 billion, underscoring growing investor interest and the increasing role of CWs in Vietnam's financial system.

The sustainability of this growth, however, depends critically on liquidity. Option pricing theory, particularly the Black–Scholes framework, highlights the central role of volatility in determining derivative value, while empirical evidence from emerging markets such as China demonstrates that higher volatility not only raises warrant prices but also fuels speculative trading, reinforcing the link between volatility and liquidity. Given Vietnam's retail-driven market structure, short-term trading strategies are likely to magnify this relationship, creating both opportunities and risks. Against this backdrop, investigating the determinants of CW liquidity—especially the role of volatility alongside other market factors—becomes essential for informing investors, guiding issuers, and supporting regulatory efforts to ensure sustainable market development.

In the context of Vietnam's emerging covered warrant (CW) market, several studies have examined aspects such as trading performance and issuance effects. Although the Vietnamese CW market has expanded rapidly since its inception, most existing studies remain descriptive, focusing on market development, product life cycles, or issuance effects on underlying stocks rather than identifying the determinants of warrant liquidity. Domestic research, such as Nguyen Thi Anh Tram (2020) and Le Phuong Lan et al. (2024), relies mainly on descriptive statistics and event-study approaches, without employing comprehensive quantitative models to test factors such as volatility, moneyness, the risk-free rate, or underlying trading activity. By contrast, international studies highlight that liquidity is shaped by both micro and macro drivers—including market volatility (Cao & Wei, 2010; Bollen & Whaley, 2004), moneyness (Whalley, 2011), and underlying trading volume (Chan & Jelic, 2007)—yet their findings remain mixed and context dependent (e.g., Chordia et al., 2003; Muzaffar & Malik, 2024). This inconsistency, combined with Vietnam's retail-dominated investor base and the absence of alternative derivatives such as stock options, underscores the need for an updated, data-driven analysis. In addition, the absence of alternative derivative products, such as stock options or single-index futures, makes CWs the only tool to access leverage at a low cost.

In particular, no study in Vietnam has applied the linear regression model (OLS) with cross-sectional data of more than 1,100 expired CW codes to quantify the relationship between quantitative factors (volatility, moneyness, risk-free rate, trading period, etc.) and liquidity. International studies such as Muzaffar & Malik (2024) and Chordia et al. (2003) also recorded conflicting results related to the impact of volatility on liquidity, especially when applying different proxies (CTV, TR, etc.). This further demonstrates the need for an updated, in-depth, and appropriate study in the context of Vietnam.

Against this backdrop, this study examines the key factors influencing the liquidity of covered warrants (CWs) in the Vietnamese stock market, with particular emphasis on market volatility and trading-related characteristics. The analysis contributes to the literature on derivative market dynamics in emerging economies and offers implications for investors and policymakers. This study makes three main contributions: First, it evaluates covered-warrant liquidity using two complementary proxies—total trading volume (CTV) and turnover ratio (TR)—to capture both absolute and relative market activity. Second, it disentangles the effects of market volatility, firm-level volatility, moneyness, underlying trading volume, the risk-free rate, and trading period, thereby clarifying mixed evidence from prior international studies. Third, it derives implications for issuers and regulators in Vietnam's retail-driven market, where covered warrants remain the only widely accessible leverage instrument, offering guidance for product design and market oversight.

The remainder of this paper is structured as follows: Section 2 reviews the related literature and develops the research hypotheses. Section 3 describes the data and methodology, Section 4 presents the empirical results, and Section 5 concludes with implications.

2. Literature review

2.1. Liquidity of the Covered Call Warrant

The financial market is a dynamic environment where financial instruments evolve to meet investors' diverse needs. Among these instruments, covered warrants have gained significant attention due to their ability to provide leveraged exposure to underlying stocks while limiting potential losses. However, the liquidity of covered warrants is often influenced by various factors, with stock volatility being one of the most crucial determinants (Klinpratoom, 2010). Understanding the relationship between stock volatility and covered warrant liquidity is essential for investors, issuers, and policymakers to ensure an efficient and stable market.

Liquidity in financial markets refers to the ability to buy or sell assets without causing significant price fluctuations. For covered warrants, liquidity is shaped by factors such as trading volume, bid-ask spreads, market depth, and the market-making activities of issuers. Higher liquidity levels lead to lower transaction costs and more efficient pricing, making covered warrants more appealing to investors (Amihud & Mendelson, 1986). A study by Aitken and Segara (2005) explores how the introduction of new covered warrants impacts liquidity in the Australian stock market. The researchers use relative trading volume and bid-ask spreads as key metrics to assess liquidity changes. Their findings show a notable increase in relative

trading volume following the introduction of covered warrants. However, while there is an observed widening of bid-ask spreads, the results are inconclusive regarding whether these spreads differ significantly before and after warrant listings across different estimation periods. Despite this, the observed increase in bid-ask spreads aligns with their findings of a decline in the price of the underlying assets, suggesting potential market adjustments. To measure liquidity in financial markets, including the covered warrant market, researchers and practitioners use various metrics that capture different aspects of market activity and efficiency. These measures include trading volume, bid-ask spread, turnover ratio, Amihud illiquidity ratio, and market depth. Each measure has distinct meanings and applications in empirical research and market analysis.

Measure	Formula	Meaning	Application	Users	References
Trading Volume	$Trading\ Volume = \sum_{i=1}^{n} Q_i$	Total number of units traded over time	Assessing overall market activity	Investors, policymakers	Team, 2023
Bid-Ask Spread	$Bid - Ask\ Spread\ (\%) = \frac{Ask\ Price - Bid\ Price}{Ask\ Price}$	Difference between bid and ask prices	Evaluating transaction costs	Traders, brokers	Killian, 2025
Turnover Ratio	$Turnover\ Ratio = \frac{Trading\ Volume}{Total\ Oustanding\ Units}$	Trading volume divided by outstanding units	Measuring trading frequency relative to supply	Researchers	Chen, 2022
Amihud Illiquidity Ratio	$Amihud\ Illiquidity\ Ratio = \frac{1}{D}\sum_{d=1}^{D}\frac{\lvert R_d\rvert}{V_d}$	Price impact per unit of trading volume	Analyzing liquidity under volatile conditions	Academics	Amihud, 2002
Market Depth	$Order\ Book\ Depth = \sum_{i=1}^{n} Q_i$	Quantity of buy/sell orders at various price levels	Understanding order book dynamics	Issuers, regulators	Jón Daníelsson and Richard Payne, 2001

Table 1. Liquidity Measurement Metrics

(Source: Author's work)

2.2. Determinants and Covered Call Warrant liquidity

Volatility is a central concept in finance, reflecting the dispersion of returns for a given security or market index. It is commonly measured by standard deviation and variance, which quantify return fluctuations around the mean and serve as foundations for risk modeling and value-at-risk (VaR) frameworks (Schwert, 1990; Hayes, 2024). Historical volatility captures past risk profiles, while implied volatility, inferred from options prices, offers a forward-looking gauge of expected market fluctuations (Hull, 2016). Indicators such as the CBOE Volatility Index (VIX), Beta, Average True Range (ATR), and Bollinger Bands are widely applied in both academic research and practice to assess short- and long-term volatility (CBOE, 2024; Saxo Group, 2025). Higher volatility often stimulates speculative demand, increasing trading activity in covered warrants, but it also raises hedging costs for issuers and widens bid-ask spreads (Chordia et al., 2001; Brennan & Schwartz, 1977). In emerging markets, this dynamic frequently attracts retail participation

seeking to exploit price swings (Morck et al., 2000). Cross-country evidence shows that while Germany and Switzerland emphasize implied volatility, the UK relies more on historical volatility and beta, and Australia combines both historical and technical indicators (FTSE Russell, 2024; ASX, 2024). The empirical literature highlights mixed effects of volatility on liquidity. In China, idiosyncratic volatility was shown to reduce short-term liquidity (Frontiers in Psychology, 2022). In the US, shocks to stock volatility widened bid-ask spreads and diminished liquidity across equity and bond markets (Chordia, Sarkar, & Subrahmanyam, 2003). Conversely, Muzaffar and Malik (2024) found a consistent negative relationship between volatility and liquidity across Asian emerging markets, emphasizing transaction costs and risk aversion.

Empirical evidence suggests that the trading volume of underlying assets has a considerable impact on the liquidity of covered warrants. Chan and Jelic (2007), examining the Taiwanese market, found that abnormal trading volumes in underlying stocks during expiration periods resulted in decreased warrant liquidity. This was attributed to the reallocation of investors' attention and resources toward the underlying assets, particularly at expiration when hedging activities ceased. Using event-study methodology with turnover ratios as proxies for trading volume, the study confirmed that spikes in underlying activity can negatively affect covered warrant liquidity. Similarly, Whalley (2011) provided a supply-side perspective, noting that issuers hedge their warrant positions dynamically using the underlying asset. When underlying trading volumes rise sharply, issuers face higher transaction costs in their hedging strategies, which contributes to wider bid-ask spreads and reduced warrant liquidity. His dynamic hedging model, applied to markets such as Australia, Spain, and Germany, demonstrated how institutional settings and transaction costs interact to shape liquidity dynamics.

Beyond trading activity in underlying assets, other determinants also influence covered warrant liquidity, notably moneyness, the risk-free interest rate, and the trading period. Moneyness, defined as the proximity of a warrant's strike price to the underlying asset price, is a key driver of investor behavior. Warrants that are closer to being "in the money" tend to be more actively traded and exhibit narrower spreads, reflecting higher profit potential. Whalley (2011) and related studies of the UK warrant market confirmed that in-the-money warrants enjoy significantly better liquidity than out-of-the-money instruments. Similarly, the risk-free interest rate exerts a negative influence: higher rates raise the cost of holding warrants, reduce speculative demand, and widen bid-ask spreads. Da Fonseca and Zaatour (2012), focusing on the Brazilian options market, found that elevated interest rates were associated with reduced trading activity and broader spreads, illustrating how macroeconomic conditions such as monetary policy directly affect derivative market liquidity. Finally, the trading period of warrants plays an important role. Longer maturities provide greater flexibility for investors to adjust their strategies and for issuers to manage hedging more effectively. As shown by Atilgan et al. (2017) in the Istanbul Stock Exchange, warrants with longer trading periods displayed higher trading volumes and narrower bid-ask spreads than those with shorter durations, indicating that time to expiration enhances market stability and liquidity.

2.3. Vietnamese context: empirical findings

In Vietnam, covered warrants (CWs) were officially introduced in 2019 as secured securities issued by qualified securities companies (SCs) under strict regulation by the Ministry of Finance and the State Securities Commission (SSC). Currently, only call warrants are permitted, with underlying stocks limited to VN30 constituents. CWs provide investors with leveraged exposure, diversify market products, and remove foreign ownership limits, thereby facilitating foreign capital inflows and enhancing market liquidity.

Market development has been rapid. By February 2020, over 2.4 million investor accounts were registered, with 99% belonging to individuals (SSC, 2020). Domestic studies highlight both opportunities and risks. Nhã An (2019) found that early divestment of CWs is often more beneficial for investors due to rapid time-value decay near expiration. Nguyễn Thị Anh Trâm (2020), analyzing data from HOSE, SSC, and major securities firms, reported strong growth in issuance, trading volume, and foreign participation, but also noted limited eligible underlying stocks and inconsistent liquidity across issuances.

More recently, Lê Phương Lan et al. (2024) examined 113 CWs on the HNX and HOSE using event study methods. Their findings suggest that CW issuance significantly affects market liquidity by altering turnover ratios, abnormal trading volumes, and bid-ask spreads, though it does not change the intrinsic valuation of underlying stocks. Collectively, these studies show that CWs enhance market depth and diversification but continue to face constraints in product diversity and liquidity stability.

2.4. Research gaps

Overall, previous studies have focused on the early stages or specific maturity cycles of CWs in Vietnam. However, they have not delved deeply into the factors affecting the liquidity of call-covered warrants; instead, they have concentrated on conceptual and classification aspects of CWs. Therefore, the objective of our study is to fill this gap by examining the specific factors that influence the liquidity of covered warrants in the Vietnamese stock market, aiming to identify the key determinants that shape this relationship.

The formulation of our research hypotheses is anchored in both theoretical pricing models and empirical evidence from emerging markets. The first two hypotheses highlight the pivotal role of volatility in influencing the value and appeal of covered warrants. According to the Black-Scholes model, increased underlying volatility (UV) enhances warrant pricing and piques investor interest, subsequently boosting liquidity. Similarly, elevated market-level volatility (MV) stimulates speculative demand in retail-focused markets such as Vietnam, resulting in more active trading of CWs.

In addition to volatility, the model accounts for the trading volume of underlying assets (UTV), which, when excessively high, can distract investors and raise issuer hedging costs, ultimately diminishing CW liquidity. Moneyness (MO) is employed as a proxy for profit potential; CWs that are closer to or in-the-money tend to attract increased trading interest, thereby enhancing liquidity. From a macroeconomic perspective, a rise in the risk-free interest rate (RFR) increases opportunity costs, which discourages speculative trading and negatively affects liquidity. Finally, extended trading periods (TP) provide investors

and issuers with greater strategic flexibility and capacity for risk management, ultimately fostering improved liquidity. In light of these insights, the following hypotheses are proposed:

H1: The volatility of the underlying assets (UV) during the covered warrant's trading period positively impacts the liquidity of the covered warrants.

H2: The market's volatility (MV) during the covered warrant's trading period negatively impacts the liquidity of covered warrants.

H3: The total trading volume of the underlying asset (UTV) during the covered warrant's trading period positively impacts the liquidity of the covered warrants.

H4: The moneyness of covered warrants (MO) negatively impacts their liquidity during the covered warrant's trading period.

H5: The risk-free interest rate (RFR) negatively impacts the liquidity of covered warrants during their trading period.

H6: The trading period (TP) covered by warrants positively impacts their liquidity.

3. Data & methodology

3.1. Data collection

In this study, data on 1,105 expired covered call warrants were collected from three primary sources: FiinPro Platform, the Vietstock website, and the Investing.com website. The dataset spans the period from June 2019 to January 2025, the full universe of publicly listed and expired covered call warrants within the Vietnamese financial market during this timeframe.

3.2. Measurement of Covered Call Warrant Liquidity and Its Determinants

Liquidity is assessed using two primary complementary indicators. The first is the total trading volume of covered call warrants, measured as the cumulative sum of daily trading volumes over the entire trading period. This indicator provides a comprehensive view of market activity by capturing the frequency and intensity of transactions over time (Dino, 2023). The second is the turnover ratio, calculated as the ratio of total trading volume to the total listed volume of the warrant, thereby reflecting the level of trading activity relative to its market availability (Ma, Yang & Su, 2021).

The volatility of the underlying asset and market captures the dispersion of returns over a specified period, reflecting the general risk and historical price fluctuation of the asset and market index (Mallikarjunappa, T., & Afsal, E. M, 2008; Samsudin, N. I. M., Mohamad, A., & Sifat, I. M, 2021). This dispersion is measured by the classic standard deviation approach:

$$S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}} \quad (1)$$

Moneyness represents the relative position of the underlying asset's price to the warrant's exercise price. It is measured using the parity ratio, defined as the spot price divided by the exercise price (Hsieh, Chen-Ling & Goo, 2009). Based on this ratio, moneyness is commonly classified into five categories including: deep in-the-money, in-the-money, at-the-money, out-of-the-money, and deep out-of-the-money.

The risk-free rate is estimated by the yield of the one-year Vietnamese government bond. This approach aligns with prior research on financial markets, where short-term government bond yields are commonly used as the benchmark risk-free rate (Ang et al., 2006; Bianconi, M., MacLachlan, S., & Sammon, M., 2015). Moreover, since most covered warrants are traded in the short maturity period, using short-term yield government bonds would be a more appropriate choice.

Trading period reflects the effective duration during which a covered warrant is available for trading. It is measured as the total number of trading days between the listing date and the last trading date in which the last trading date is defined as the final working day when the warrant remains tradable, typically occurring two to five days prior to its expiration.

3.3. Empirical approach

To enhance consistency and interpretability, all trading volumes are standardized by converting them into millions of units (dividing by 1,000,000). This transformation reduces the scale of numerical values while preserving relative differences across observations, thereby facilitating clearer interpretation of regression coefficients. The conversion is applied uniformly to all data points prior to statistical analysis to ensure both accuracy and comparability.

The study then employed Ordinary Least Squares (OLS) regression to analyze the factors affecting the liquidity of covered call warrants. This approach is appropriate for our study since it offers the best linear unbiased estimators under the Gauss-Markov assumption (Wooldridge, 2016). The empirical model in this study is inspired by Cao and Wei (2010), who investigated the determinants of option market liquidity. Therefore, based on the core ideas of their analytical framework, the study constructed a simplified regression model using OLS to align with the characteristics of our dataset and research context.

$$\mathrm{CTV} = \beta_0 + \beta_1 \times \mathrm{UV} + \beta_2 \times \mathrm{MV} + \beta_3 \times \mathrm{UTV} + \beta_4 \times \mathrm{MO} + \beta_5 \times \mathrm{RFR} + \beta_6 \times \mathrm{TP} + \varepsilon \quad \textbf{(2.a)}$$

$$\mathrm{TR} = \beta_0 + \beta_1 \times \mathrm{UV} + \beta_2 \times \mathrm{MV} + \beta_3 \times \mathrm{UTV} + \beta_4 \times \mathrm{MO} + \beta_5 \times \mathrm{RFR} + \beta_6 \times \mathrm{TP} + \varepsilon \quad \textbf{(2.b)}$$

Where CTV denotes the covered warrant trading volume, TR the turnover ratio, UV the underlying asset volatility, MV the market volatility, UTV the underlying asset trading volume, MO the moneyness, RFR the risk-free rate, TP the trading period, and ε the error term.

To ensure the robustness of the regression results, the study applies diagnostic tests for both multicollinearity and heteroskedasticity. Multicollinearity is assessed using the Variance Inflation Factor

(VIF), where values above 10 indicate severe correlation among predictors (Gujarati & Porter, 2009); in such cases, corrective measures such as variable elimination, data transformation, or principal component analysis (PCA) are considered. While the Heteroskedasticity is examined using the White test (White, 1980), with the null hypothesis assuming homoscedasticity of error terms. If the test indicates heteroskedasticity, heteroskedasticity-robust standard errors will be employed to adjust the variance–covariance matrix of the estimators, thereby preserving the validity of hypothesis testing and enhancing the reliability of coefficient estimates and statistical inferences.

4. Results and discussion

4.1. Overview of the Covered Call Warrant Market in Vietnam

As of January 2025, the Vietnamese covered call warrant market comprises a total of 30 underlying securities and is supported by 11 key issuers, all of which are securities firms, including independent companies as well as subsidiaries of banks or financial conglomerates. Among these, 17 underlying securities belong to the VN30 Index, which represents the 30 largest and most liquid companies on the Ho Chi Minh Stock Exchange (HOSE), while the remaining 13 securities are outside the VN30. However, in fact, among the 13 securities not included in the VN30 as of January 2025, 10 were previously included in the VN30. Furthermore, the total number of issuance rounds for VN30 underlying securities is 7.5 times higher than that for non-VN30 securities, with 975 and 130 issuance rounds, respectively. The primary reason for this concentration is that the Vietnamese covered warrant market remains in its early stages, so to mitigate the risk of price manipulation in covered warrants through the manipulation of their underlying securities, stringent eligibility criteria have been established for underlying stocks. These criteria include listing on a Vietnamese stock exchange, meeting specific market capitalization thresholds, maintaining sufficient liquidity, ensuring a minimum free-float ratio, demonstrating stable financial performance, and complying with other regulatory requirements set by the State Securities Commission of Vietnam (SSC), as outlined in Circular No. 107/2016/UBCKNN. Consequently, stocks within the VN30 Index are more likely to meet these eligibility requirements. As a result, the issuance of covered warrants is predominantly concentrated in this group of stocks. Additionally, due to the structure of the Vietnamese stock market, large-cap companies that attract the most investor interest are predominantly in the banking sector, followed by the real estate sector.

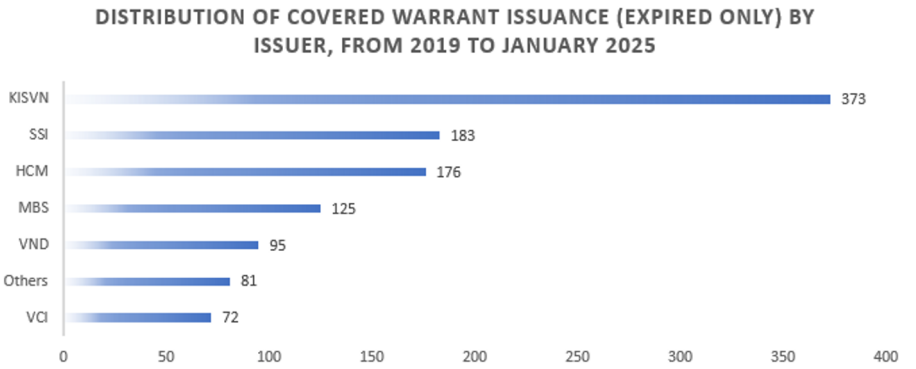

Figure 1. Distribution of covered warrant issuance by issuer (2019-1/2025)

(Source: Author's work)

According to Ho Chi Minh City Securities Corporation (HSC), covered warrants in Vietnam have a maturity that typically ranges from at least 3 months to up to 2 years. Compared to international practices, the maturity of covered warrants in Vietnam appears relatively shorter in practice. For example, In Hong Kong, the Hong Kong Stock Exchange (HKEX) stipulates that covered warrants typically have a maturity period ranging from 6 months to 2 years which is similar to the regulations of the Financial Services Commission (FSC) and the Korea Exchange (KRX) or in countries like Germany or France, where the covered warrant markets are well-developed, the maturity of covered warrants can range even longer, from 6 months to 5 years. The distribution of covered warrants in Vietnam, based on their maturity measured in months, shows that the majority of warrants had relatively short maturities. Specifically, warrants with maturities between 3 and 6 months accounted for the largest proportion, with 707 issuances. This is followed by 270 warrants with maturities between 6 and 9 months, and 106 warrants between 9 and 12 months. Only 22 warrants had longer maturities, ranging from 12 to 15 months. This distribution reflects a strong market preference for short-term instruments in the covered call warrant segment during the observed period.

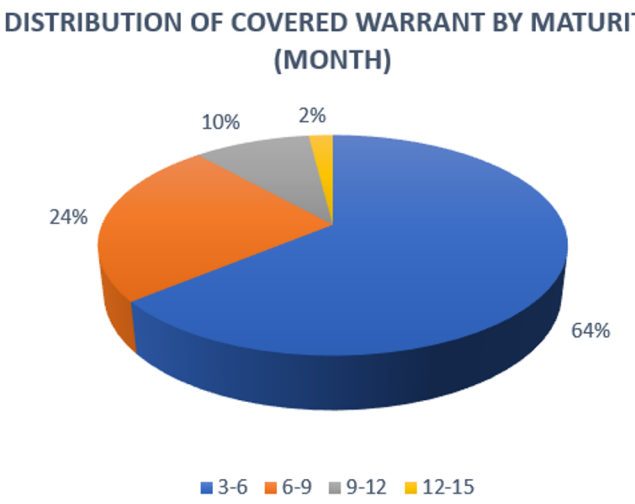

Figure 2. Distribution of covered warrant by maturity (month)

(Source: Author's work)

4.2. Descriptive statistics

		N	Mean	St.dev	Min	Max
Independent variable	CTV	1105	42.92	96.01	0.00465	1865.96
	TR	1105	8.30	12.21	0.00102	148.43
Dependent variable	UV	1105	0.02	0.01	0.01	0.07
	MV	1105	0.01	0.00	0.00	0.02
	MO	1105	1.02	0.32	0.10	2.74
	UTV	1105	1253.47	1368.39	20.62	7568.60
	RFR	1105	1.82	1.02	0.39	4.07
	TP	1105	120.70	52.72	40.00	299.00

Table 2. Descriptive statistics of variable

(Source: Author's work)

Table 2 presents the descriptive statistics of the variables based on the 1,105 observations. The liquidity of covered warrants is measured using two different proxies comprising CTV and TR.averages 42.92 with a standard deviation of 96.01, ranging from 0.00465 to 1,865.96, indicating significant variation in trading activity. TR records a mean of 8.30 (SD 12.21), ranging from 0.00102 to 148.43, reflecting considerable fluctuations. Among the independent variables, UV averages 0.0211 (SD 0.0071), MV 0.0124 (SD 0.0035), and MO 1.0249 (SD 0.3215), showing moderate variation in volatility, market conditions, and moneyness.

The underlying asset's trading volume varies widely (mean 1,253.47, SD 1,368.39). RFR averages 1.8151 (SD 1.0211), and TP ranges from 40 to 299 days (mean 120.70, SD 52.72), reflecting diverse trading durations across warrants.

	CTV	TR	UV	MV	MO	UTV	TP
CTV	1.00						
TR	0.59	1.00					
UV	-0.08	-0.05	1.00				
MV	-0.12	-0.07	0.67	1.00			
MO	-0.01	0.01	-0.15	-0.18	1.00		
UTV	0.25	0.18	0.04	-0.11	0.24	1.00	
TP	0.26	0.20	-0.12	-0.13	0.02	0.47	1.00

Table 3. Correlation Matrix of Variables

(Source: Author's work)

Table 3 presents the correlation matrix for the study variables. CTV and TR, two alternative liquidity proxies, are moderately correlated (0.593), indicating consistency in capturing warrant liquidity. Both proxies are positively related to TP and UTV, suggesting that warrants linked to more actively traded stocks and longer trading periods tend to be more liquid. Among independent variables, UV and MV are highly correlated (r = 0.67), reflecting the close relationship between stock volatility and market fluctuations, but both show weak correlations with liquidity measures. UTV also shows a positive correlation with CTV (r = 0.25), indicating that higher trading activity in the underlying asset may enhance covered warrant liquidity.

Variable	VIF	1/VIF
UV	1.95	0.51
MV	1.87	0.53
UTV	1.45	0.69
MO	1.41	0.71
RFR	1.41	0.71
TP	1.35	0.74
Mean VIF	1.57	

Table 4. Variance Inflation Factor (VIF) Table

(Source: Author's work)

The variance inflation factor (VIF) values for the independent variables, ranging from 1.35 to 1.95, indicate low levels of multicollinearity in the model. Specifically, UV has a VIF of 1.95, MV 1.87, UTV 1.45, MO and RFR 1.41, and TP 1.35, with a mean VIF of 1.57. All values are well below the common threshold of 5, suggesting that multicollinearity is not a major concern which ensures that the relationships between

independent variables and the dependent variable can be interpreted reliably (Birgirsson, T. O., & Dahling, S. E., 2023).

	White's Test χ^2 (df)	P-value
CTV	61.19 (27)	0.0002
TR	64.38 (27)	0.0001

Table 5. White test for Heteroscedasticity

(Source: Author's work)

The results of the White test and the Cameron & Trivedi decomposition indicate that the p-values are all below 0.05, thereby rejecting the null hypothesis of homoskedasticity. This suggests the presence of heteroskedasticity in the model, which can distort the reliability of standard OLS estimates, particularly the standard errors and hypothesis testing. Since heteroskedasticity is detected based on the White and Cameron & Trivedi tests, the standard errors are adjusted using the heteroskedasticity-robust (White) estimator to ensure valid inference. The coefficient estimates remain based on OLS.

4.3. Results and discussion

The regression results show that both liquidity proxies, total trading volume (CTV) and turnover ratio (TR), are well explained by the independent variables. In terms of explanatory power, the model for CTV records a higher R-squared value (0.1086) compared to TR (0.0933), indicating that the selected variables account for more variation in CTV than in TR.

Table 6 indicates that across both models, MO (Moneyness) and RFR (Risk-free rate) are statistically significant with negative coefficients. The negative effect of MO indicates that liquidity decreases as warrants become more in-the-money. This is consistent with prior studies suggesting that the highest liquidity is usually observed near at-the-money (ATM), while warrants far from their intrinsic value tend to be less liquid (Garay, Justiniano, & Lopez, 2003; Bollen & Whaley, 2004; Cao & Wei, 2010). While at-the-money warrants offer a balance between risk and cost, making them particularly attractive to short-term investors in Vietnam's predominantly retail market (Huang, Liu, & Shu, 2023; Cao & Wei, 2010). Similarly, the negative impact of risk-free rate is consistent with Black & Scholes (1973) and Hull (2016), as higher risk-free rates increase the opportunity cost of holding warrants, shifting capital to safer instruments like government bonds (Merton, 1971).

According to the regression result, UTV (Underlying trading volume) and TP (Trading period) are significant and positively related to liquidity in both models. This supports the notion that higher activity in the underlying stock enhances warrant liquidity through increased investor participation, visibility, and arbitrage opportunities (Cao & Wei, 2010; Chan & Pinder, 2000; Henderson & Pearson, 2011; Gang, 2016). Moreover, longer-lived warrants provide more trading opportunities and reduce short-term risk, which attracts more investors (Black, 1975; Brennan & Schwartz, 1977; Chan & Wei, 2001).

MV (Market volatility) is significant only for CTV with a large negative coefficient, reflecting investors' defensive behavior during turbulent markets (Cao & Wei, 2010; Chordia, Roll & Subrahmanyam, 2005; Battalio & Schultz, 2006). Its insignificance in TR may stem from the relative nature of the turnover ratio, which responds differently to volatility than absolute trading volume (Bollen & Whaley, 2004). UV (historical volatility of the underlying) is insignificant in both models, suggesting that in Vietnam's market, liquidity is driven more by market-wide factors than firm-specific volatility (Chan & Pinder, 2000). The difference from prior studies (e.g., Samsudin, Mohamad & Sifat, 2021) may derive from the use of cross-sectional rather than panel data, as well as the limited volatility variation among highly liquid VN30 stocks.

	OLS Model	
	CTV	TR
UV	-118.01	55.51
	[0.705]	[0.351]
MV	-1844.63***	-77.39
	[0.003]	[0.458]
MO	-39.68***	-5.31***
	[0]	[0]
UTV	0.0134***	0.0012***
	[0]	[0.007]
RFR	-11.55***	-2.94***
	[0]	[0]
TP	0.3119**	0.0382***
	[0.016]	[0]
R - squared	0.1086	0.0933
N	1105	1105

Note: Figures in parentheses are p-values. *, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Reported values are regression coefficients. Source: Author's work.*

Table 6. The Regression Results

(Source: Author's work)

No.	Hypothesis	Finding	Supported references
H1	The volatility of the underlying assets (UV) during the covered warrant's trading period positively impacts the liquidity of the covered warrant	Rejected	
H2	The market's volatility (MV) during the covered warrant's trading period positively impacts the liquidity of the covered warrants.	Partial supported	Cao & Wei (2010) Bollen & Whaley (2004)
H3	The total trading volume of the underlying asset (UTV) during the covered warrant's	Supported	Cao & Wei (2010) Chan & Pinder (2000)

	trading period positively impacts the liquidity of the covered warrant		Henderson & Pearson (2011)
H4	The moneyness of covered warrants (MO) negatively impacts their liquidity during the covered warrant's trading period	Supported	Garay, U., Justiniano, R., & Lopez, M (2003) Bollen & Whaley (2004) Cao & Wei (2010)
H5	The risk-free interest rate (RFR) negatively impacts the liquidity of covered warrants during their trading period	Supported	Merton (1971) Hull (2016)
H6	The trading period (TP) covered by warrants positively impacts their liquidity	Supported	Black (1975)

Table 7. The Hypothesis Analysis Result

(Source: Author's work)

5. Conclusion & recommendations

The study offers several notable contributions to the academic field on covered call warrant (CW) liquidity in emerging markets, especially Vietnam, by using data on 1,105 expired call CWs, while previous studies such as Bollen & Whaley (2004), Cao & Wei (2010), and Whalley (2011) focused mainly on developed markets. The results show that market volatility (MV) has a negative impact on total trading volume, while the volatility of the underlying stock (UV) is insignificant, contrary to previous mixed results (Chordia et al., 2005; Muzaffar & Malik, 2024) and consistent with the retail investor-dominated emerging markets context (Wong et al., 2018; Samsudin et al., 2021). Simultaneously, the level of "moneyness" and the trading volume of the underlying stock are the most important predictors of CW liquidity, which is consistent with behavioral finance theory (Cao & Wei, 2010; Henderson & Pearson, 2011) and corroborates the findings in Hong Kong (Chan & Wei, 2001), Thailand (Klinpratoom, 2010). Finally, the use of both absolute (CTV) and relative (TR) liquidity measures shows that each index reflects investor behavior in a different way, offering insights for future research.

The study not only consolidates existing theories on market behavior and derivative asset valuation, but it also offers a fresh perspective on features of financial instruments in emerging markets, where investor behavior, market structure, and development level differ from those in developed markets. In addition, the study also contributes to the foundation for further studies on valuation, risk management, or investment strategies using warrants. In practical terms, the research results provide meaningful reference value. Gaining insights into the determinants affecting liquidity will support individual and institutional investors in making effective investment decisions, minimize liquidity risks and optimize warrant trading strategies. For securities companies and organizations issuing warrants, the research results support adjusting the issuance strategy, choosing the right timing, maturity and instrument structure to increase the warrant's liquidity in the secondary market. Simultaneously for management agencies, the research provides empirical data to review and improve the legal framework and management of warrant issuance, thereby contributing to promoting the sustainable development of the derivatives market in Vietnam.

However, there are several limitations to this study that should be noted. First, the use of cross-sectional data limits the ability to capture fluctuations over time, which may lead to the omission of short-term effects and potential endogeneity issues in the model. Second, the underlying stock volatility is measured as standard deviation over a fixed period, which may not fully reflect actual or implied volatility. Third, the study focuses only on covered call warrants, which limits the generalizability. Finally, the lack of intraday liquidity and bid-ask spread data prevents a more detailed analysis of liquidity characteristics of covered call warrant.

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