Commonality in Liquidity across Options and Stock Futures Markets

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Abstract

This study investigates the existence of common aggregate factors driving liquidity across different markets. The evidence provided suggests that liquidity across different European options and stock futures markets co-moves. This implies that liquidity risk could not be mitigated by investing in options and stock futures as both market experience simultaneous liquidity shocks. These findings are relevant to investors when timing their hedging, speculation, or arbitrage strategies.

Keywords: Liquidity Commonality, Stock Futures, Options

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1. Introduction

Liquidity has been a major aspect of market microstructure research as it is considered a determinant of market behaviour and an indicator of its sound functioning. Early microstructure models seek to explain the idiosyncratic liquidity of individual financial assets, but give little insight on systematic patterns in liquidity. The presence of co-movement in assets' liquidity implies a risk to investors as it represents an undiversifiable portion of liquidity risk. Liquidity co-movement is first investigated by Chordia et al. (2000). They argue that, much like returns, liquidity of single assets might comprise both firm-specific and market components. The latter implies that individual assets' liquidities might be simultaneously affected by market-wide factors, i.e. there exist a commonality in liquidity.

Most studies of liquidity commonality focus on equity markets. Research in other financial asset classes remains limited (Pu, 2009; Cao and Wei, 2010; Marshall et al., 2013; Verousis et al., 2016). Another underdeveloped yet important research area is commonality in liquidity across different markets (Chordia et al., 2005; Pu, 2009; Mancini et al., 2013; Frino et al., 2014). Investing in different markets might enable investors to diversify liquidity risk. In extreme market conditions, financiers update margins, potentially creating a funding liquidity risk to investors as margins increase and their positions lose value (Brunnermeier and Pedersen, 2009). Adam-Müller and Panaretou (2009) suggest offsetting such risk related to futures hedges using options markets. Such hedging would be restricted if liquidity across the two markets co-moves.

The aim of this paper is to investigate the potential presence of commonality in liquidity across European stock futures and options markets during 2008-2010, a period which was characterised by extreme market conditions, when liquidity risk is more likely to materialise. It is argued that options and stock futures markets could experience simultaneous periods of high or low liquidity owing to common liquidity demanders being present in both markets. Assuming the example of basket and institutional trading, several investors are simultaneously buying/selling assets included as new information reaches the market. They could seek to enter an offsetting position in a future or option contract at the same time, thus leading to simultaneous selling/buying pressures in futures and options markets. As a result, liquidity in both markets might co-move. (Kamara et al., 2008; Karolyi et al., 2012; Lowe, 2014; Koch et al., 2016; Moshirian et al., 2017). A similar argument could be presented for sentiment-oriented trading. For instance, if the price of a certain asset is predicted to fall, selling a futures contract or writing a call option on that asset is a speculative strategy to seek profits. When traders share the same sentiment about future price movements, their demand to trade in futures and options markets would take the same direction at the same time, thus increasing liquidity co-movement (Chordia et al., 2000; Bernardo and Welch, 2003; Morris and Shin, 2004).

This paper is structured as follows. Section 2 expands the methodology used to test commonality, and describes the data available for this study. Section 3 reports the results, followed by concluding remarks in Section 4.

2. Data and Methodology

2.1. Data selection

High frequency data are obtained from NYSE LIFFE London, Paris, Brussels, and Amsterdam for both option and futures contracts on equity from January 2008 until December 2010. This period coincides with the global financial crisis, which was characterised by a tightening in funding liquidity thus potentially causing an increase in liquidity commonality (Rösch and Kaserer, 2014). For option (call and put) contracts, the database provides maturity date, strike price, time-stamped volume and price for asks, bids and trades. For futures, the data contain maturity date, time-stamped ask and bid prices along with the quantity associated with each quoted price. The data are screened following the approaches documented in Cao and Wei (2010) and Verousis et al. (2016).

Contracts associated with a zero-trading volume are omitted from the dataset. The level of option moneyness is defined as the daily opening price of the underlying equity, S, over the option strike, K, i.e S/K. To avoid pricing issues related to moneyness, deep in-the-money (with a moneyness level higher than 1.1 for call options or lower than 0.9 for put options) and deep out-the-money (with a moneyness level lower than 0.9 for call options or higher than 1.1 for put options) contracts are dropped. Price data for the underlying assets are collected from Bloomberg.

Furthermore, option and futures contracts whose remaining maturities are either very short (less than 7 days) or very long (more than 90 days) are dropped. Short-maturity contracts are defined as having between 7 and 30 days to maturity; medium-maturity contracts have 31 to 60 days to maturity; long-maturity contracts have 61 to 90 days to maturity. Moreover, contracts with less than 5 observations on a given day and less 500 observations per year are dropped. Quotes with bid-ask spreads higher than 1.50 are also omitted, following Wei and Zheng (2010).[2]

[2] More outliers are eliminated by only keeping observations time-stamped between 08:00 and 16:00, dropping half days, and omitting contracts with negative and zero bid-ask spreads.

2.2. Liquidity measures

The following liquidity measures are used: the *relative quoted spread* and the *quoted depth* suggested by Chordia et al. (2000), and *quote slope* suggested by Hasbrouck and Seppi (2001).

The relative spread is one of the most commonly used measures of liquidity. Dividing by the midpoint enables the measure to be comparable across different assets:

$$\mathrm{BAS}_{\mathrm{i,t}} = \frac{\mathrm{p}^{\mathrm{A}}_{\mathrm{i,t}} - \mathrm{p}^{\mathrm{B}}_{\mathrm{i,t}}}{\mathrm{P}^{\mathrm{M}}_{\mathrm{i,t}}} \tag{1}$$

Where $\mathrm{p}^{\mathrm{A}}_{\mathrm{t}}$ and $\mathrm{p}^{\mathrm{B}}_{\mathrm{t}}$are the ask and bid prices, respectively. The midpoint price is defined as the average of the bid and ask prices: $\mathrm{P}^{\mathrm{M}}_{\mathrm{i,t}} = \frac{\mathrm{p}^{\mathrm{A}}_{\mathrm{i,t}} + \mathrm{p}^{\mathrm{B}}_{\mathrm{i,t}}}{2}$.

Depth measures the ability of the market to process large volumes of trade, with minimum impact on prices. The quoted depth is calculated as the sum of the bid and ask volumes:

$$\mathrm{D}_{\mathrm{i,t}} = \mathrm{q}^{\mathrm{A}}_{\mathrm{i,t}} + \mathrm{q}^{\mathrm{B}}_{\mathrm{i,t}} \tag{2}$$

Where $\mathrm{q}^{\mathrm{A}}_{\mathrm{i,t}}$ and $\mathrm{q}^{\mathrm{B}}_{\mathrm{i,t}}$ are the best ask and the best bid volume in the order book for contract i.

The quote slope is introduced by Hasbrouck and Seppi (2001) as the spread divided by the log depth. This measure can be illustrated as a linear function whose slope reveals the degree of liquidity. If the quantity of asked or bid contracts increases, or if the buy and sell prices draw closer, the slope decreases, i.e. liquidity improves:

$$\mathrm{QSlope}_{\mathrm{i,t}} = \frac{\mathrm{p}^{\mathrm{A}}_{\mathrm{i,t}} - \mathrm{p}^{\mathrm{B}}_{\mathrm{i,t}}}{\ln(\mathrm{q}^{\mathrm{A}}_{\mathrm{i,t}}) + \ln(\mathrm{q}^{\mathrm{B}}_{\mathrm{i,t}})} \tag{3}$$

The equally weighted average of each liquidity measure is calculated across each 30-minute interval on a trading day d. There are 16 intervals on each trading day. To neutralise any time-of-the-day effect, the three measures are standardised as follows: let $\tilde{L}^{i}_{t,d}$ refer to a liquidity measure for a contract i at interval t on day d, μ^{i}_{t} and σ^{i}_{t} are its mean and standard deviation across intervals t on all days in the time series, respectively (Hasbrouck and Seppi, 2001). Each liquidity measure is standardized as:

$$L_{t,d}^{i} = \frac{\tilde{L}_{t,d}^{i} - \mu_{t}^{i}}{\sigma_{t}^{i}} \tag{4}$$

2.3. Methodology

According to theoretical predictions, commonality in liquidity is stronger during extreme market conditions. Commonality across futures and options contracts could arise from demand-side factors. Further, it is expected that commonality in liquidity across futures and option contracts with the same underlying assets should be stronger. Two hypotheses are defined:

Hypothesis 1: liquidity commonality across derivative markets – there exist systematic patterns across the liquidities of stock futures and options markets;

Hypothesis 2: common underlying – liquidity exhibits a stronger commonality across stock futures and options written on the same underlying assets.

Commonality tests are conducted using Principal Component Analysis (PCA), following e.g. Connor and Korajczyk (1986), and Korajczyk and Sadka (2008). The principal components are extracted from the observed values of each liquidity measure in futures and options contracts combined. PCA compresses the original liquidity predictors into fewer components which capture the common underlying trend in liquidity of both markets. The emergent components, therefore, record as much information as possible on the variability of the liquidity measure in options and futures. They represent the common underlying factors potentially causing liquidity in both markets to co-move. The strength of these factors in driving commonality in liquidity across markets is given by the R-squared. To this end, each measure is regressed on the extracted components as follows:

$$L_{t,d}^{i} = \beta^{i} F_{t,d} + \varepsilon_{t,d}^{i} \quad (5)$$

Where $F_{t,d}$ is the vector of extracted common factors in interval t on a trading day d. The cross-sectional average R^2 of the above regression indicates whether there is commonality in the liquidity measure in question. The higher is the R^2, the stronger the commonality.

3. Results

3.1. All contracts

Figure 1 displays the daily dynamics of R-squared in the bid-ask spread across SSF and options markets. The figure shows that the level of commonality is high throughout the time series and varies by approximately 50%, on average. This is confirmed by the PCA results reported in Table 1, which includes the eigenvalues and cumulative contributions of each component, and the cross-sectional average R-squared. Panel A includes all contract maturities; Panels B, C, and D represent short-, medium-, long-maturity contracts, respectively.

[Insert Figure 1 here]

Table 1 reveals ample evidence of commonality in liquidity across stock futures and options markets. The strongest commonality occurs in Qslope. in Panel A, the extracted components account for 42% of the total variance of Qslope for both futures and option contracts. Commonality is at similar levels for both relative spread and depth, with the total variances explained by the components being 26% and 25%, respectively. This implies that there are underlying factors driving from 25% to 42% of liquidity of stock futures and options simultaneously. Commonality in Qslope and spreads is strongest for short-maturity contracts, while long-maturity contracts exhibits the highest level of systematic patterns in liquidity measure by depth. This implies that short-maturity contracts are more sensitive to changes in markets' spreads, while long-maturity contracts are more sensitive to changes in markets' depth. Short hedgers aiming to sell an asset or speculators aiming to achieve short-term profits would take positions in short-maturity contracts. During extreme market conditions, the costs of trading and the risk associated with such positions increase, thus overall spreads widen. Long-maturity contracts are targeted by institutional investors willing to enter long hedge positions, particularly when prices are volatile. During periods of intense institutional trading, markets' ability to sustain large orders decreases.

[Insert Table 1 here]

3.2. Common-underlying contracts

Further tests investigate whether contracts written on the same asset exhibit stronger commonality in liquidity. After excluding contracts with different underlying assets, the PCA is used to extract the first most meaningful components explaining a large proportion of variation in liquidity measured by relative spread, depth, and Qslope. Table 2 reports the eigenvalues and cumulative contributions of each component, and the cross-sectional average R-squared.

[Insert Table 2 here]

The results shown in Table 2 confirm the presence of strong co-movement in liquidity across stock futures and options markets. Consistent with Table 1, the strongest commonality occurs in Qslope. The degree of commonality is still evident when liquidity is measured by depth and relative spread. As in the previous analysis, the results reveal that commonality in Qslope and spreads is stronger for short-maturity contracts, whereas it is stronger for long-maturity contracts' depth.

Decomposing components using contracts written on the same underlying assets demonstrates increased explanatory power and their contribution in total variance of all liquidity measures. For instance, the cumulative explained variance of the QSlope increases to nearly 60% in contracts written on the same underlying assets, compared to 42% found in the previous analysis. The emergent components for spread explain approximately 26% of the total variance in the full sample, whereas they account for up to 35% of the total variance in contracts with common underlying assets. Similar comparisons are observed for depth and QSlope.

4. Discussion and Conclusions

This study reveals new evidence on the presence of common factors affecting liquidity in stock futures and options simultaneously. The systematic patterns in liquidity across the two derivative markets are argued to be caused by demand-side factors, where investors might trade in the same direction, at the same time, in both stock futures and options, thus causing the liquidity in both markets to co-move. The principal component analysis reveals first-time evidence on co-movement in liquidity across the two derivative markets, potentially owing to common trading behaviour, institutional ownership, or investor sentiment. Systematic patterns in liquidity can also emerge from the underlying asset's characteristics and trading, as proposed by Cao and Wei (2010) who show that the degree of commonality in options is related to the size and volatility of the underlying stock. In further tests of commonality across stock futures and options written on the same underlying asset, the results reveal a greater extent of liquidity commonality. Overall, commonality across stock futures and options, whether these share the same underlying asset or not, remains high enough to conclude that a liquidity shock in stock futures is accompanied by a similar shock in options market, and vice versa. These findings are relevant to investors as they could reduce liquidity costs when constructing their hedging, speculation, and arbitrage strategies by avoiding simultaneous periods of low liquidity in both derivative markets. The results imply that investors are not able to diversify their liquidity needs by opening positions in different derivative markets, as liquidity shocks occur simultaneously in both markets, although geographically and contractually distinct. During liquidity dry-ups, transaction costs increase and market depth decreases concurrently in both markets, i.e. offsetting a position across markets becomes more costly and insufficient to meet funding needs, thus decreasing the ability of investors to maintain their margin accounts and increasing their liquidity risk. The co-movement of liquidity in both markets suggests that cross-market strategies to diversify systematic liquidity risk might not be particularly successful.

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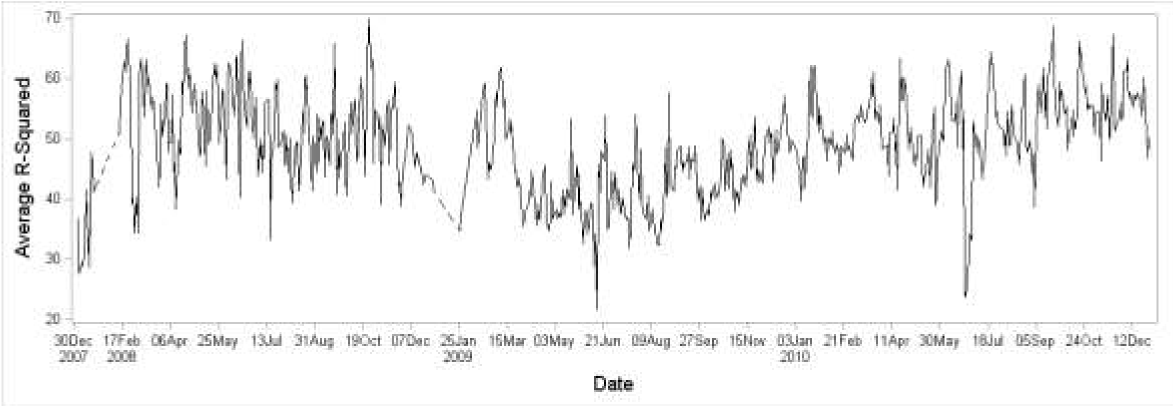

Figure 1: Daily Commonality across SSF and Options Markets

This figure displays the time series dynamics of commonality in the bid-ask spread across SSF and options markets. The level of commonality is quantified by the daily cross-sectional average of R^2 value, the goodness of fit of the following regression model:

$$BAS_{t,d}^{i} = \beta^{i} F_{t,d} + \varepsilon_{t,d}^{i}$$

Where $BAS_{t,d}^{i}$ is the bid-ask spread of contact i at interval t on day d and $F_{t,d}$ is the vector of extracted common factors in interval t on a trading day d.

Table 1: Principal Component Analysis of Relative Spread, Depth, and Qslope across Stock Futures and Options Markets

The table reports the eigenvalues and the cumulative contribution of the first three components extracted from the principal component analysis, as well as the cross-sectional average R-squared for the time-series regression of each contract's liquidity measure (including stock futures and options) on the first, the first two, and the first three components, as specified in:

$$L_{t,d}^{i} = \beta^{i} F_{t,d} + \varepsilon_{t,d}^{i}$$

Where $L_{t,d}^{i}$ is the liquidity measure standardised using its mean and standard deviation in interval t across all days of time series.

Factor	Spread			Depth			Qslope		
	Eigen-value	Cumulative Explained Variance (%)	R-squared (%)	Eigen-value	Cumulative Explained Variance (%)	R-squared (%)	Eigen-value	Cumulative Explained Variance (%)	R-squared (%)
PANEL A: All contract maturities (N=1034)									
1	155.37	15.71	13.86	85.84	10.28	11.65	234.89	23.92	20.02
2	61.07	21.88	20.68	64.18	17.97	20.79	129.11	37.07	35.52
3	40.48	25.98	26.49	59.23	25.06	27.03	48.84	42.04	42.00
PANEL B: Short-maturity contracts (N=347)									
1	62.84	19.16	17.41	40.70	15.36	14.38	102.41	29.86	25.77
2	23.71	26.38	26.15	22.72	23.93	23.19	58.98	47.05	45.98
3	16.45	31.40	31.98	18.71	30.99	30.22	15.42	51.55	50.50
PANEL C: Medium-maturity contracts (N=353)									
1	51.01	15.99	14.58	51.91	15.40	13.17	92.72	26.64	21.00
2	20.51	22.42	23.69	28.44	23.84	22.06	55.02	42.45	41.58
3	15.96	27.42	28.63	25.50	31.41	29.77	14.51	46.62	45.79
PANEL D: Long-maturity contracts (N=334)									
1	60.43	14.42	15.41	45.23	14.64	12.88	77.45	24.36	20.19
2	31.17	21.86	23.56	31.78	24.92	25.22	39.66	36.83	36.02
3	22.85	27.31	28.78	27.48	33.82	34.45	19.16	42.85	42.66

Table 2: Principal Component Analysis of Relative Spread, Depth, and Qslope across Stock Futures and Options Contracts with Common Underlying Assets

The table reports the eigenvalues and the cumulative contribution of the first three components extracted from the principal component analysis, as well as the cross-sectional average R-squared for the time-series regression of each contract's liquidity measure (including only stock futures and options written on the same underlying asset) on the first, the first two, and the first three components, as specified in:

$$L_{t,d}^{i} = \beta^{i} F_{t,d} + \varepsilon_{t,d}^{i}$$

Where $L_{t,d}^{i}$ is the liquidity measure standardised using its mean and standard deviation in interval t across all days of time series.

Factor	Spread			Depth			Qslope		
	Eigen-value	Cumulative Explained Variance (%)	R-squared (%)	Eigen-value	Cumulative Explained Variance (%)	R-squared (%)	Eigen-value	Cumulative Explained Variance (%)	R-squared (%)
PANEL A: All contract maturities (N=357)									
1	78.14	23.75	21.68	40.40	13.25	13.00	130.65	37.12	33.45
2	22.79	30.68	29.23	35.79	24.98	23.77	68.13	56.47	55.21
3	15.06	35.25	35.74	20.55	31.72	31.04	12.60	60.05	58.93
PANEL B: Short-maturity contracts (N=119)									
1	32.40	28.42	25.77	11.14	12.66	11.95	45.82	39.84	36.78
2	8.97	36.29	34.72	8.05	21.81	19.44	24.01	60.72	58.94
3	5.95	41.51	41.64	7.06	29.84	30.38	4.53	64.66	63.12
PANEL C: Medium-maturity contracts (N=121)									
1	27.39	24.46	22.54	15.82	14.25	12.23	45.71	37.78	34.27
2	8.69	32.22	31.33	13.88	26.76	24.01	25.27	58.67	57.36
3	6.01	37.59	37.95	9.15	35.01	34.20	4.74	62.59	61.36
PANEL D: Long-maturity contracts (N=117)									
1	24.34	22.53	22.71	15.83	16.67	14.15	33.66	33.00	24.92
2	9.02	30.89	30.59	12.92	30.27	28.14	17.14	49.81	48.11
3	6.09	36.53	36.95	7.52	38.18	39.77	5.46	55.17	54.33