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**LIKVIDITÁS-EGYÜTTMOZGÁS VIZSGÁLATA AZ ÁRUPIACON –
ROBOSZTUSSÁGVIZSGÁLAT ÉS AZ OPEC BEJELENTÉSEK
HATÁSA**

**A STUDY OF LIQUIDITY COMMONALITY IN THE COMMODITY
FUTURES MARKET – TESTING FOR ROBUSTNESS AND THE
EFFECTS OF OPEC ANNOUNCEMENTS**

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1. INTRODUCTION, LITERATURE REVIEW

Liquidity is a widely studied field, which became more important after the global financial crisis of 2008. Understanding its role in the proper functioning of markets has gained more attention in the last two decades (Amihud, 2002; Acharya and Pedersen, 2005).

The first important study of commonality in liquidity comes from Chordia et al. (2000). They find that market-wide liquidity is correlated with individual proxies and there is a strong systematic liquidity factor in the US equity market. This means that co-movement exists and there is a systematic risk in liquidity that needs to be hedged. Since then, more studies have been published investigating this phenomenon in the US equity market (Hasbrouck and Seppi, 2001; Pástor and Stambaugh, 2001), in the international equity market (Korajczyk and Sadka, 2008; Brockman et al., 2009; Karolyi et al., 2012), in the FX market (Mancini et al., 2013; Sensoy et al., 2021) or in the bond market (Chordia et al., 2004; Richter, 2022). Most studies are based on the market model from Chordia et al. (2000), but some studies (also) implement principal component analysis (Hasbrouck and Seppi, 2001; Korajczyk and Sadka, 2008; Mancini et al., 2013).

Liquidity commonality in the commodity futures market has been proven to be significant by Marshall et al. (2013). To the best of our knowledge, only Marshall et al. (2013) conducted research on this topic using two high-frequency and one daily measure. They implemented market model regression, supply-side regression and principal component analysis.

Chordia et al. (2000) suggest as a next step in researching liquidity commonality to identify specific macroeconomic influences that correlate with liquidity. Brockman et al. (2009) conduct global research on liquidity commonality in stock markets. They show that macroeconomic announcements (interest rate settings, consumer prices, unemployment, GDP) drive liquidity commonality. Chordia et al. (2004) test whether holidays, crises, macroeconomic announcements (GDP, employment, inflation) and tick size changes influence liquidity commonality in the US stock and bond market. They find that commonality is higher on Fridays, around holidays and during crisis periods. These studies were published before the global financial crisis. Emerging market research is rare. The study of Sensoy (2016) concludes that among several domestic and global monetary and

macro-announcements, only Fed and US GDP announcements have a significant impact on liquidity commonality in the Turkish equity market. Sensoy et al. (2021) also look at the foreign exchange (FX) market, where they find that before (after) ECB (Fed) monetary policy announcements the commonality increases significantly.

OPEC announcements have a significant effect on the energy market. There are many studies on their impacts on oil (futures) prices, in a narrower sense on abnormal returns (Demirer and Kutan, 2010; Lin and Tamvakis, 2010), volatility (Schmidbauer and Rösch, 2012), abnormal returns and volatility (Loutia et al., 2016), correlation (Klein, 2018) and term structure of futures prices (Spencer and Bredin, 2019). The results regarding the returns are unanimous. Cut decisions have a stronger effect and result in positive price returns. Production level increases generate negative returns, while no changes result in negative or non-significant returns. Lin and Tamvakis (2010) and Loutia et al. (2016) find that the impacts depend on the current price environment. When oil prices are low, OPEC decisions have greater influence.

Schmidbauer and Rösch (2012) conclude that market participants have significant pre-announcement anticipations, when OPEC decides to cut or to maintain quotas. The aftereffects are always significant, especially the longest after increase decisions. Klein (2018) finds that OPEC announcements increase the correlation between WTI and Brent spot and futures prices in the short-run. There is no significant evidence of long-term trends in connection with the OPEC meetings. These observations are important when it comes to hedging strategies, as the correlations reduce the hedging potential.

Spencer and Bredin (2019) contribute to existing literature in two ways. While studies usually examine returns or volatility, they investigate the relationship between OPEC announcements and term structure variables (level, slope and curvature) for WTI crude oil futures. They also distinguish two OPEC decisions that result in no changes (maintain production and failure to agree). This distinction is important, as the two announcements have different information content.

Commodity futures have become a popular asset class for financial investors (non-commercial traders). Open interest rose dramatically from 2004 onward. We can refer to this process as the financialization of the commodity markets. Cheng and Xiong (2014)

review the literature on this topic and find that this process does not seem to distort commodity prices. Traditionally, commodity producers (commercial hedgers) traded commodity futures to hedge their price risks, usually taking short positions. Since 2004 commodity index traders (CITs) have shown increased activity in the market, taking long positions with speculating motives. Irwin and Sanders (2012) find that three structural changes can be distinguished in the commodity market. First, when in 2006 electronic trading took place, this enabled access to the commodity futures market. ETFs were also developed in this period, this way market participants could access commodities without brokers. The third structural change is that investments tracking commodity indexes have spread.

We also review the literature on commodity financialization to specify our sample period. Cheng and Xiong (2014) mention the year 2004, while Irwin and Sanders (2012) distinguish three periods 2000 to 2003, 2004 to 2008 and 2009 to 2011. Main et al. (2018) investigate whether financialization affects risk premiums but find no difference between the two subperiods 1990-2004 and 2005-2014. Adams et al. (2020) group the financialization of commodities into three phases. ‘Pre-financialization’ until the end of 2003; from 2004 until June 2014 the ‘Financialization’ period; and finally, the ‘De-financialization’ period, which could have started with the oil price drop in June 2014. Ding et al. (2021) conclude that financialization impacts volatility and correlations with the stock market. They divide their data into two periods, one from 1992 until 2003 and the other one from 2004 until 2020. Marshall et al. (2013) also examine the effects of financialization from 2004 onward.

Our study on liquidity commonality in the commodity futures market introduces new aspects to the literature. Liquidity commonality in the commodity market has not been a widely researched field. Our main contribution to previous research is the implementation of low-frequency liquidity proxies. Studies regarding liquidity commonality usually source high-frequency data and use only one or just a few liquidity measures. We test for robustness and find that the Amihud illiquidity measure proves to be the most robust proxy, followed by the High-Low Spread Estimator, the Closing Percent Quoted Spread and Volatility over Volume.

We aim to find whether liquidity commonality is present in the commodity futures market using daily data for 16 commodities with a sample period from 2000 to 2021. We also investigate how commodity financialization affects liquidity commonality using 2 sub-

periods. With the use of the market model regression from Chordia et al. (2000) we can determine that liquidity commonality in the commodity market exists and is present more strongly after 2004, which support the results of Marshall et al. (2013). We include the supply-side regression from Hameed et al. (2010) and find that commonality is stronger in the event of market downturns when Amihud is applied. Another contribution of this study is the examination of how OPEC announcements (cut, increase, maintain and failure to agree) affect liquidity commonality in the energy market. We find that the impact is significant. Volatility over Volume is the most, and the High-Low Spread Estimator is the least sensitive to announcements. We also investigate whether liquidity co-movements react differently depending on the classification of the announcements. We can conclude that the energy market differentiates between the decisions that result in no change (maintain and failure to agree).

The rest of the paper is organised as follows. Section 2 reviews the data used in this research. Section 3 explains the methodology implemented in our study. Section 4 discusses the results of the study, followed by conclusions and recommendations for further work in Section 5.

2. DATA

For examining liquidity commonality in the commodity market, we use first generic futures data. We use futures rather than spot data, because futures data are more available, liquid and more commonly known when it comes to commodities. We access daily data via Bloomberg. The variables obtained are the bid, ask, open, close, high, and low prices, as well as the volume. The prices start from the beginning of 2000 until the end of 2021. Days with negative prices or no volumes are excluded from the time series.

Table 1 – Commodities used in this study

Ticker	Name	2021	2022
Energy			
CO1 Comdty	Brent crude oil	16.10%	17.19%
CL1 Comdty	WTI crude oil	21.78%	20.34%
QS1 Comdty	Gasoil	5.45%	4.78%
NG1 Comdty	Natural gas	2.80%	3.33%
JV1 Comdty	Gasoline	3.70%	4.34%
HO1 Comdty	Heating oil	4.08%	3.50%
Grains			
C 1 Comdty	Corn	5.75%	6.54%
W 1 Comdty	Chicago wheat	3.74%	3.64%
KW1 Comdty	Kansas wheat	1.48%	1.40%
S 1 Comdty	Soybean	3.97%	4.64%
Livestock			
LH1 Comdty	Lean hogs	2.13%	2.36%
LC1 Comdty	Live cattle	4.46%	3.76%
FC1 Comdty	Feeder cattle	1.40%	1.25%
Metals			
GC1 Comdty	Gold	6.27%	5.33%
SI1 Comdty	Silver	0.60%	0.64%
HG1 Comdty	Copper	4.97%	5.80%
SUM		88.68%	88.84%

We report the commodities included in this study grouped by commodity families. The last two columns detail the weights they represent in the S&P GSCI Index. Source: S&P GSCI Methodology (2022).

The S&P GSCI Commodity Index represents the most important commodities for the global economy. We source data for commodities from the Index that are available in our sample period. We include 16 commodities that represent all commodity families (energy, livestock, agricultural, precious metals, and industrial metals / classifications from the Index). The commodities that we include are the same as the commodities analysed by

Marshall et al. (2013). The groups used for further analysis came from Karstanje et al. (2015), where they classified the commodities a bit differently. This way Gold-Silver-Copper can form one group, but data for Softs (Cocoa, Coffee, Cotton, Sugar) isn't available for the sample period. We have confidence that these commodities can show us the main trends in the market, as they represent approximately 90% of the S&P GSCI Index. The tickers, names and weights can be found in Table 1.

Table 2 – Descriptive statistics

	AR	SD	Skewness	Kurtosis	JB	ADF	Q(20)	Q2(20)
Brent crude oil	5.5%	36.1%	-0.298	13.509	26433***	-16.861**	50.499***	2475.632***
WTI crude oil	5.3%	40.4%	0.112	18.103	54436***	-16.930**	77.409***	4729.856***
Gasoil	5.4%	32.7%	-0.221	9.975	11653***	-16.989**	31.035*	1884.087***
Natural gas	2.3%	53.6%	0.876	10.871	15513***	-17.530**	32.897**	359.082***
Gasoline	5.2%	30.2%	-0.856	30.922	186708***	-15.041**	62.880***	499.291***
Heating oil	6.0%	35.6%	-0.521	10.195	12609***	-18.204**	34.408**	1106.681***
Corn	5.3%	27.9%	-0.341	13.066	24287***	-17.115**	31.315*	174.507***
Chicago wheat	5.6%	30.4%	0.278	4.880	916***	-18.675**	30.799*	934.845***
Kansas wheat	5.2%	28.2%	0.157	4.888	874***	-18.221**	18.716	679.054***
Soybean	5.2%	24.1%	-0.633	8.299	7082***	-17.521**	20.819	1184.451***
Lean hogs	1.8%	36.9%	0.339	29.770	171084***	-18.975**	55.326***	20.136
Live cattle	3.3%	18.3%	-1.010	15.607	38891***	-19.197**	67.027***	146.019***
Feeder cattle	3.2%	15.9%	0.161	15.456	37042***	-18.109**	70.314***	339.017***
Gold	9.2%	17.2%	-0.096	8.984	8552***	-18.593**	46.595***	936.186***
Silver	7.2%	30.2%	-0.689	9.886	11765***	-18.363**	32.292**	1238.567***
Copper	8.1%	26.6%	0.330	13.868	28283***	-16.355**	102.004***	1814.156***

We report the descriptive statistics for all 16 commodities. AR is the annual return, SD denotes annualized standard deviation. JB is the Jarque-Bera normality test statistics. ADF is the Augmented Dickey-Fuller unit root test statistics. Q(10) and Q2(10) are the Ljung-Box tests for 20th order serial correlations for returns and squared returns, respectively.

The descriptive statistics reported in Table 2 tell us that Gold has the highest annualized return in the sample period, while Feeder cattle presents the lowest risk depicted by the smallest standard deviation. Half of the commodities have a left-skewed distribution, while half of them are right-skewed. Since all kurtosis values are greater than 3, all commodities have fat-tailed leptocurtic distributions. Based on the Jarque-Bera normality test statistics, we have to declare that all commodities have a skewness and kurtosis that is different from the normal distribution. ADF test statistics tell us that no unit root is present, the time series are stationary. The results also show that most series are autocorrelated.

Figure 1 – S&P GSCI Commodity Index



We plot the time series of S&P GSCI Commodity Index for our sample period from 1 January 2000 to 31 December 2021. Data are sourced from Bloomberg.

We also investigate whether liquidity co-movements are present at all times in the commodity futures market. We create two sub-periods, one from 2000 to 2003 and another one from 2004 to 2021 based on Marshall et al. (2013), Cheng and Xiong (2014), Adams et al. (2020) and Ding et al. (2021). We plot the prices of the S&P GSCI Commodity Index for our sample period in Figure 1. We can recognize the boom from 2004, then the impacts of the 2007-2009 financial crisis, then a rise again until the oil price drop in 2014, when crude oil prices dropped by 50% within a few months (Adams et al., 2020). The pandemic also affected commodity prices, but the index is rising again since the outbreak.

Spencer and Bredin (2019) study the effects of OPEC announcements on the WTI crude oil futures term structure (level, slope and curvature). The authors work with a sample period from December 1991 to September 2017. They collected and organized the announcements in this period, grouping the outcomes of the meetings into four sections. The two basic decisions are 'agreement to increase production' (INC) and 'agreement to decrease production' (CUT). The authors distinguish two types of outcomes when there is no change in the official quota allocations. The 'agreement to maintain production' (ATM) and the 'failure to agree on production intentions' (FTA) mean that there is no change in allocations, but markets are more optimistic about the first and more cautious when the latter occurs. We use the classifications and dates from this study to investigate the effects of OPEC announcements on liquidity commonality. The announcement dates and classifications can be found in Table 3. 66 of the 70 announcements fall on a trading day, which consist of 10 INC, 15 FTA, 26 ATM and 15 CUT decisions.

Table 3 – Classification of OPEC announcements

<u>Announcement</u>		<u>Announcement</u>		<u>Announcement</u>	
Date	Type	Date	Type	Date	Type
2000.03.29	INC	2004.02.10	CUT	2008.10.24	CUT
2000.06.21	INC	2004.03.31	ATM	2008.12.17	CUT
2000.09.11	INC	2004.06.03	INC	2009.03.15	FTA
2000.10.30	INC	2004.07.15	INC	2009.05.28	ATM
2000.11.13	FTA	2004.09.15	INC	2009.09.10	ATM
2001.01.17	CUT	2004.12.10	ATM	2009.12.22	ATM
2001.03.19	CUT	2005.01.30	ATM	2010.03.17	ATM
2001.06.05	FTA	2005.03.16	INC	2010.10.14	ATM
2001.07.03	ATM	2005.06.15	INC	2010.12.11	ATM
2001.07.25	CUT	2005.09.20	FTA	2011.06.08	FTA
2001.09.27	ATM	2005.12.12	FTA	2011.12.14	ATM
2001.11.14	CUT	2006.01.31	ATM	2012.06.14	FTA
2001.12.28	CUT	2006.03.08	ATM	2012.12.12	ATM
2002.03.15	FTA	2006.06.01	ATM	2013.05.31	FTA
2002.06.26	ATM	2006.09.11	FTA	2013.12.04	ATM
2002.09.19	ATM	2006.10.20	CUT	2014.06.11	FTA
2002.12.12	CUT	2006.12.14	CUT	2014.11.27	ATM
2003.01.12	INC	2007.03.15	FTA	2015.06.05	ATM
2003.03.11	ATM	2007.09.11	INC	2015.12.04	FTA
2003.04.24	CUT	2007.12.05	ATM	2016.06.02	FTA
2003.06.11	ATM	2008.02.01	FTA	2016.09.28	CUT
2003.07.31	ATM	2008.03.05	ATM	2016.11.30	CUT
2003.09.24	CUT	2008.09.10	FTA	2017.05.25	ATM
2003.12.04	ATM				

We source OPEC announcement dates and classifications from Spencer and Bredin (2019). INC denotes 'agreement to increase production', CUT denotes 'agreement to decrease production', ATM denotes 'agreement to maintain production', FTA denotes 'failure to agree production intentions'. The latter two mean no change in quota allocations.

3. METHODOLOGY

3.1. LIQUIDITY MEASURES

Le and Gregoriou (2020) review low-frequency liquidity measures and divide them into four categories (transaction cost, volume, price impact and multidimension-based). Proxies that capture the trading cost dimension are good estimators of bid-ask spread, but price impact ratios are better when it comes to long-term financial stability. Although daily estimates might not measure transaction costs or price impacts as accurately as benchmarks (Proportional Effective Spread, Proportional Quoted Spread or the slope of the price function - λ), the use of these proxies can provide computational savings that allow us to analyse longer time series or data for more assets (Fong et al., 2017).

We calculate four liquidity proxies for our regressions, two Price Impact-Based Measures and two Transaction Cost-Based Measures. These are namely, Amihud illiquidity ratio, Volatility over Volume, Closing Percent Quoted Spread and High-Low Spread Estimator. These proxies prove to be the best performing estimates for high-frequency benchmarks (Goyenko et al., 2009; Corwin and Schultz, 2012; Fong et al., 2017; Fong et al., 2018; Le and Gregoriou, 2020).

3.1.1. Price Impact-Based / cost-per-dollar-volume proxies

The calculations of the two Price Impact-Based Measures are based on Bedowska - Sójka and Kliber (2019).

The Amihud illiquidity ratio:

$$Amihud_t = |r_t| / \log(volume_t)$$

The original proxy in Amihud (2002) is the ratio of daily absolute return to daily dollar volume. Using a logarithmic transformation helps to correct for extreme values and gives us a proxy that can be used in regressions easily.

As we couldn't obtain daily dollar volumes, we multiplied the volume data (quantity) with the closing price for a given day to get an estimated daily turnover. This ratio is the most commonly used liquidity proxy in finance literature, because the required data can be obtained easily. Goyenko et al. (2009) find that low-frequency liquidity proxies can capture price impact difficultly, but the Amihud ratio produces a statistically significant positive

correlation with benchmarks. Fong et al. (2017) also have similar results, stating that Amihud is the best daily cost-per-dollar-volume proxy.

The Volatility over Volume:

$$VoV_t = \frac{\ln\left(\frac{H_t}{L_t}\right)}{\sqrt{volume_t}}$$

Fong et al. (2018) introduce this proxy as a low-frequency cost-per-dollar-volume measure. They find that the daily version dominates the Amihud measure when comparing them to the benchmark (lambda) both on a global and on a US basis. VoV is based on the same idea as the Amihud illiquidity proxy. The numerators are similar in the sense that they both measure volatility. VoV replaces the daily absolute return with the return from high and low prices within a given day. Volume is also square rooted to minimize the impact of extreme values. We use the same modification for daily turnover as for the Amihud ratio.

3.1.2. Transaction Cost-Based / percent-cost proxies

As Le and Gregoriou (2020) summarized, transaction costs are expenses, that we associate with the execution of a trade. Implicit costs are for example bid–ask spreads, size of transaction, and timing of trade execution.

Closing Percent Quoted Spread:

$$CPQS_t = \frac{P_{Ask,t} - P_{Bid,t}}{(P_{Ask,t} + P_{Bid,t})/2}$$

Chung and Zhang (2014) introduce this proxy as a daily version of the benchmark Proportional Quoted Spread. They compare the benchmark with other daily proxies and find that the strongest correlation (0.97) can be found with their measure, but only for NASDAQ stocks. On NYSE/AMEX the benchmark's correlation is higher with Effective Tick, but not significantly different from the correlation with CPQS. Fong et al. (2017) find that Closing Percent Quoted Spread is the best daily percent-cost proxy for global research, with a 0.728 correlation to Quoted spread in the US equity market.

The High-Low Spread Estimator:

$$CSA_t = \frac{2(e^{at} - 1)}{1 + e^{at}}$$

$$\text{where } \alpha_t = \frac{\sqrt{2\beta_t} - \sqrt{\beta_t}}{3-2\sqrt{2}} - \sqrt{\frac{\gamma_t}{3-2\sqrt{2}}}, \quad \beta_t = [\ln(\frac{H_t}{L_t})]^2 + [\ln(\frac{H_{t+1}}{L_{t+1}})]^2 \quad \text{and } \gamma_t =$$

$$\ln((\max\{H_t, H_{t+1}\})/(\min\{L_t, L_{t+1}\}))$$

Corwin and Schultz (2012) construct a bid-ask spread estimator from daily high and low prices, which generally outperforms other low-frequency estimators. Their sample period is from 1993 through 2006 for US stocks. They show that their proxy is highly correlated with the TAQ-based effective spread, outperforming the Roll covariance estimator, the effective tick estimator and the LOT measure.

We use the following modifications as introduced by the authors. We adjust for overnight price changes. If $t+1$ day low (high) price is above (below) the t day close, then we adjust the $t+1$ day high and low prices by decreasing (increasing) them with the overnight change ($low_{t+1} / high_{t+1} - close_t$). We also set negative estimators to zero, as Corwin and Schultz (2012) suggests, this way we can get more accurate estimates than either including or deleting the observations.

3.2. VOLATILITY MEASURE

We need a volatility estimator for the market model and for the supply-side regression. Sensoy et al. (2021) calculates Garman-Klass volatility as one of the control variables and Richter (2022) also uses this measure in his research.

$$\sqrt{0,5(\log(P_t^H) - \log(P_t^L))^2 - (2\log(2) - 1)(\log(P_t^C) - \log(P_t^O))^2}$$

Garman and Klass (1980) calculate volatility from the high P_t^H , low P_t^L , close P_t^C and open P_t^O prices, respectively.

3.3. LIQUIDITY COMMONALITY MEASUREMENT

3.3.1. Market model regression

Commonality in liquidity means that systematic liquidity is present in the analysed market. This co-movement can be a factor to look after or to be aware of, but it can also be a possibility to understand the dynamics of the financial market more deeply.

In order to test commonality between our 16 commodity futures, the following regression is used from Sensoy et al. (2021), which is based on the benchmark model from Chordia et al. (2000). Marshall et al. (2013) also measures liquidity commonality using the market model as well as principal component analysis.

$$\Delta L_{i,t} = \alpha + \beta_1 \Delta L_{M,i,t-1} + \beta_2 \Delta L_{M,i,t} + \beta_3 \Delta L_{M,i,t+1} + \beta_4 R_{M,i,t-1} + \beta_5 R_{M,i,t} + \beta_6 R_{M,i,t+1} \\ + \beta_7 \Delta V_{i,t-1} + \beta_8 \Delta V_{i,t} + \beta_9 \Delta V_{i,t+1} + \varepsilon_{i,t}$$

We run this regression for all liquidity measures calculated for all commodities to observe whether liquidity commonality can be captured, regardless of which proxy we use. We regress the change in individual liquidity on the change in market-wide liquidity as we control for market returns and volatility. For each variable, we use concurrent, lag and lead values that refer to the same, previous, and next trading day observations, respectively. We calculate the change in individual liquidity taking the first difference:

$$\Delta L_{i,t} = L_{i,t} - L_{i,t-1}$$

Market liquidity and market returns are calculated using equally weighted cross-sectional averages *excluding* the dependent variable commodity_i. The reason why we exclude commodity_i and this way each commodity has its own market liquidity and market return variable, is to eliminate a potentially misleading constraint (individual bias) from the explanatory variables. In this way, the dependent and explanatory variables are less biased (Sensoy et al., 2021).

$$\Delta L_{M,i,t} = \frac{\sum_{j=1; j \neq i}^{16} \Delta L_{j,t}}{15}$$

Market returns are calculated from mid-prices.

$$R_{M,i,t} = \sum_{j=1; j \neq i}^{16} \frac{P_{M,j,t} - P_{M,j,t-1}}{P_{M,j,t}} / 15$$

Garman-Klass volatility is calculated as the volatility variable following Sensoy et al. (2021) and Richter (2022).

3.3.2. Supply-side explanations

Similarly to Marshall et al. (2013) we examine liquidity commonality from a supply-side approach too. Hameed et al. (2010) find that liquidity (commonality) in the stock market can decrease (increase) following negative market returns. With the use of interaction variables we can test whether market downturns have an impact on commodity liquidity commonality.

Based on Hameed et al. (2010), we run the following regression.

$$\begin{aligned}
\Delta L_{i,t} = & \alpha + \beta_{LIQ,i} \Delta L_{M,i,t} + \beta_{LIQ,down,i} \Delta L_{M,i,t} D_{down,M,i,t} + \sum_{k=1}^4 \beta_{i,k} R_{M,i,t-k} \\
& + \sum_{k=1}^4 \beta_{down,i,k} R_{M,i,t-k} D_{down,M,i,t-k} + \sum_{k=1}^4 \gamma_{i,k} R_{i,t-k} \\
& + \sum_{k=1}^4 \gamma_{down,i,k} R_{i,t-k} D_{down,M,i,t-k} + \gamma_i \Delta V_{i,t} + \varepsilon_{i,t}
\end{aligned}$$

3.4. TESTING THE IMPACT OF OPEC ANNOUNCEMENTS

This is the first study to analyse the impact that OPEC announcements have on commodity liquidity commonality. We use a simple method, where we regress the time-varying commonality term on dummy variables. We are only looking for statistically significant coefficients to confirm the impact of the announcements.

Similarly to Sensoy et al. (2021), we create time-varying commonality terms. Sensoy et al. (2021) investigate whether announcements made by the Federal Open Market Committee (FOMC) and the European Central Bank (ECB) affect liquidity commonality in the foreign exchange (FX) market. For creating daily commonality measures, they use high-frequency data. They run daily market model regressions and summarize the coefficients of the market liquidity variables ($\beta_1 + \beta_2 + \beta_3$) for each currency, then take the cross-sectional average of these commonality terms.

As we can only work with daily data, we create these daily commonality terms running 21-day rolling-window market model regressions. We choose this window because one month consists of approximately 21 trading days. We summarize then average the necessary coefficients and assign this commonality measure to the 11th observation in the middle. The dummy variables are created using a three-day event window (days -1 to 1) to capture any pre- or post-announcement impacts.

$$\bar{\beta}_{L,t} = \alpha_0 + \alpha_1 Dummy_{ANN} + \varepsilon_t$$

Our first regression includes the dummy for all announcements. In the second regression we distinguish dummies for INC (agreement to increase production), CUT (agreement to decrease production), ATM (agreement to maintain production) and FTA (failure to agree on production intentions) decisions.

$$\bar{\beta}_{L,t} = \alpha_0 + \alpha_1 Dummy_{INC} + \alpha_2 Dummy_{CUT} + \alpha_3 Dummy_{ATM} + \alpha_4 Dummy_{FTA} + \varepsilon_t$$

4. RESULTS

In this section, we present the results of our research. To conclude whether there is liquidity commonality in the commodity futures market, we present the results of the market model regression first, then the results of the supply-side approach, and finally the effects of OPEC announcements on liquidity commonality.

4.1. LIQUIDITY COMMONALITY

4.1.1. Market model liquidity commonality

We present our core results for all liquidity ratios for the sample period (2000-2021), as well as detailed results for our main liquidity proxy (Amihud illiquidity ratio). We also show our findings for the sub-periods in connection with commodity financialization and our results summarized by commodity families to observe if some commodities behave differently.

Table 4 represents summarized results for the market liquidity change variables, when using the Amihud illiquidity ratio, Volatility over Volume, Closing Percent Quoted Spread and High-Low Spread Estimator adjusted for night returns, respectively. For determining whether liquidity commonality in the commodity market exists, we test following Sensoy et al. (2021) whether the cross-sectional average of $\beta_1 + \beta_2 + \beta_3$ is significantly different from zero. We find that this liquidity term is significant for all liquidity measures except for Volatility over Volume. Coefficients for VoV might be non-significant, because the daily measures are very low and standard errors are high enough for t-statistics not to reach the critical value.

Our results show that the lead and lag variables do not have a significant impact on individual liquidity change. Other studies on commonality usually find that non-concurrent coefficients are also significant (Chordia et al., 2000; Marshall et al., 2013; Sensoy et al., 2021). In the US equity market, Chordia et al. (2000) find that only 15 to 35% of the stocks have a positive and significant concurrent coefficient depending on the liquidity measure, while in Marshall et al. (2013), 81 to 100% is the significant and positive beta ratio in the commodity market. Our results show that concurrent market liquidity has a positive and significant influence on individual liquidity by 56 to 100% of the 16 commodities. Liquidity commonality seems to be more present in commodity markets.

Table 4 – Overall results summarized by proxies

	Amihud	VoV	CPQS	CSA
<i>Concurrent – coefficient</i>	0.552***	0.256*	0.246***	0.720***
Concurrent – <i>t</i> -statistic	12.412	1.847	4.965	18.867
% Positive	100%	88%	88%	100%
% + Significant	100%	56%	69%	94%
<i>Lag – coefficient</i>	-0.002	0.052	-0.002	-0.006
Lag – <i>t</i> -statistic	-0.043	0.415	-0.047	-0.176
% Positive	31%	56%	38%	38%
% + Significant	44%	19%	38%	31%
<i>Lead – coefficient</i>	-0.023	0.039	0.003	-0.016
Lead – <i>t</i> -statistic	-0.589	0.314	0.056	-0.473
% Positive	38%	56%	38%	38%
% + Significant	50%	44%	31%	25%
Adjusted R ² mean	15.92%	13.98%	1.57%	13.81%
Adjusted R ² median	13.10%	10.13%	0.80%	12.12%
$\beta_{L,t}$	0.528***	0.346	0.247***	0.698***
<i>t</i> -statistic	7.488	1.548	2.897	11.427

We report the market-model cross-sectional averages of the market liquidity coefficients and related t-stats. We use data for the 1 January 2000 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). ‘Concurrent’, ‘Lag’, and ‘Lead’ refer to the same, previous, and next trading day observations of market liquidity respectively. *, **, *** denote significance at 10%, 5% and 1% level respectively. % Positive (% + Significant) refers to the proportion of the 16 commodities, that have positive (and significant at 10% sign. level) coefficients.

One unit of concurrent market liquidity change induces ceteris paribus an average change in individual liquidity ranging from 0.246 to 0.72. Our concurrent coefficients are higher than the results from Marshall et al. (2013), where they range between 0.118 and 0.176 in the commodity market.

Liquidity measured with Amihud and CSA proxies is the most sensitive to changes in market-wide liquidity. All concurrent coefficients are positive and significant (100% and 94% respectively). Adjusted R² are also the highest for these two measures. Adjusted R² is much lower for CPQS, which means that the signal-to-noise ratio is different for this proxy. Noise is much higher, so the independent variables explain a very low proportion of the dependent variable's variance.

As the Amihud illiquidity ratio is the most commonly used price impact ratio, we report detailed results for all commodities and variables from the benchmark model in Table 5. Taking length into consideration, detailed market model results for other liquidity measures can be found in the Appendix.

Table 5 – Liquidity sensitivity to the changes in market-wide liquidity – Individual liquidity series

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.044 (1.27)	0.988*** (24.56)	0.056 (1.62)	-0.002* (-1.79)	0.003*** (2.95)	-0.001 (-0.61)	-0.008*** (-4.74)	0.043*** (22.83)	0.010*** (5.84)
WTI crude oil	0.011 (0.30)	1.178*** (26.87)	0.113*** (2.99)	-0.002 (-1.42)	0.002** (2.24)	-0.001 (-1.31)	-0.003 (-1.59)	0.038*** (21.21)	0.006*** (3.79)
Gasoil	0.090** (2.54)	0.627*** (15.28)	0.099*** (2.81)	0.000 (0.32)	0.002* (1.74)	-0.002 (-1.57)	-0.003* (-1.78)	0.022*** (11.18)	0.004** (2.22)
Natural gas	-0.071 (-0.97)	0.708*** (8.47)	-0.033 (-0.46)	0.001 (0.33)	-0.001 (-0.25)	0.001 (0.28)	-0.018*** (-6.63)	0.052*** (17.26)	0.002 (0.61)
Gasoline	0.273*** (8.13)	0.200*** (5.11)	0.012 (0.35)	-0.001 (-0.55)	0.000 (-0.41)	0.000 (0.30)	0.003 (1.09)	0.045*** (17.29)	0.007*** (3.13)
Heating oil	-0.039 (-1.04)	1.117*** (25.97)	0.069* (1.84)	0.001 (1.12)	-0.003*** (-2.68)	0.005*** (4.89)	-0.001 (-0.74)	0.029*** (13.06)	0.003* (1.75)
Corn	-0.046* (-1.71)	0.429*** (13.70)	-0.042 (-1.53)	-0.001 (-1.48)	-0.001 (-1.07)	0.002*** (2.74)	0.006*** (3.17)	0.030*** (15.01)	0.005*** (2.79)
Chicago wheat	-0.078*** (-2.60)	0.520*** (15.02)	-0.095*** (-3.16)	0.000 (-0.01)	0.001 (0.73)	0.001 (1.15)	-0.009*** (-4.80)	0.031*** (15.19)	0.005*** (2.72)
Kansas wheat	-0.062* (-1.90)	0.576*** (15.41)	-0.053 (-1.61)	0.000 (-0.29)	0.000 (-0.23)	0.001 (1.38)	-0.006*** (-3.01)	0.021*** (9.47)	0.005*** (2.61)
Soybean	-0.058** (-2.57)	0.342*** (13.05)	-0.032 (-1.39)	0.000 (0.18)	-0.002*** (-2.76)	0.001** (2.11)	0.000 (0.22)	0.043*** (20.87)	0.004** (2.32)
Lean hogs	0.017 (0.28)	0.277*** (3.96)	-0.275*** (-4.49)	0.002 (1.13)	-0.002 (-1.20)	0.001 (0.79)	-0.025*** (-4.91)	0.077*** (13.51)	0.046*** (8.83)
Live cattle	-0.015 (-0.64)	0.260*** (9.77)	-0.005 (-0.22)	0.000 (0.10)	-0.004*** (-5.09)	0.003*** (4.54)	0.014*** (5.25)	0.024*** (7.85)	0.008*** (2.84)
Feeder cattle	-0.057** (-2.48)	0.136*** (5.20)	-0.048** (-2.10)	0.000 (0.68)	-0.001 (-1.17)	0.000 (0.05)	-0.019*** (-6.67)	0.037*** (11.82)	0.014*** (4.88)
Gold	-0.022 (-1.14)	0.319*** (14.27)	-0.055*** (-2.80)	-0.003*** (-3.10)	0.003** (2.56)	-0.002* (-1.95)	-0.004* (-1.94)	0.044*** (21.04)	0.006*** (2.94)
Silver	-0.013 (-0.23)	0.704*** (11.34)	-0.100* (-1.85)	0.000 (0.20)	-0.001 (-0.39)	0.000 (0.31)	-0.005* (-1.80)	0.052*** (16.79)	0.007*** (2.63)
Copper	-0.002 (-0.06)	0.454*** (13.30)	0.024 (0.80)	-0.001* (-1.66)	0.002** (2.47)	0.000 (-0.47)	-0.002 (-1.08)	0.050*** (20.82)	-0.001 (-0.69)

We report the market-model cross-sectional averages of the market liquidity coefficients and related t-stats. We use data for the 1 January 2000 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). ‘Concurrent’, ‘Lag’, and ‘Lead’ refer to the same, previous, and next trading day observations of market liquidity respectively. *, **, *** denote significance at 10%, 5% and 1% level respectively.

At a 1% significance level, liquidity commonality is present in all 16 commodities. The lag and lead market liquidity variables have less significant coefficients. 44% and 38% of the 16 betas are significantly different from zero at a 10% significance level. 13% and 19% of the commodities have significant and positive lag and lead coefficients. Marshall et al. (2013) find that using the Amihud measure, no non-concurrent liquidity variables have significant and positive coefficients. The average Adjusted R^2 is approximately 16% while Marshall et al. (2013) have a 32% average Adjusted R^2 using Amihud. Our samples consist of the same commodities, but the periods are different. We can assume that during the period August 2009 - December 2021 the noise is higher than before.

The market return does not have a significant impact on individual liquidity changes. As we would expect, volatility has the most significant impact on individual liquidity changes, similarly to Sensoy et al. (2021). All concurrent and almost all lead coefficients are significant. For Gasoil, Chicago wheat and Feeder cattle, all market liquidity variables have significant coefficients, market-wide liquidity has a greater influence on these commodities' individual liquidities.

4.1.2. Commonality in sub-periods

Table 6 – Sub-period results

	mean	t-statistic	% + Significant	Adjusted R^2
<i>Panel A: Amihud illiquidity ratio</i>				
2000-2003	0.514***	4.374	87.5%	13.5%
2004-2021	0.563***	11.723	100.0%	17.1%
<i>Panel B: Volatility over Volume</i>				
2000-2003	0.316	0.987	43.8%	21.5%
2004-2021	0.229	1.481	50.0%	17.0%
<i>Panel C: Closing Percent Quoted Spread</i>				
2000-2003	-0.039	-0.258	12.5%	0.5%
2004-2021	0.307***	5.812	68.8%	2.1%
<i>Panel D: High-Low spread estimator</i>				
2000-2003	0.718***	7.625	93.8%	12.0%
2004-2021	0.721***	17.172	93.8%	14.3%

We report cross-sectional averages of concurrent market liquidity coefficients and related t-stats for the 1 January 2000 - 31 December 2003 and 1 January 2004 – 31 December 2021 sub-periods. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables. % + Significant refers to the proportion of the 16 commodities, that have significant and positive coefficients at a 10% sign. level. We also report cross-sectional averages of Adjusted R^2 . *, **, *** denote significance at 10%, 5% and 1% level respectively.

We now investigate whether liquidity commonality is present during all circumstances, presenting our market-model results broken down into two sub-periods in Table 6.

Liquidity commonality was also significantly present in the earlier sub-period, when investment flows into commodity markets were relatively flat, based on the results for Amihud and CSA proxies. The grains family is the only one with statistically significant average concurrent market liquidity coefficients for all proxies in the first sub-period. This could mean that grains have always been of great interest, because the agricultural field needs the most hedging for protection from uncertain crops and prices.

Commonality using VoV is not significant in this approach, but detailed findings show that commonality for metals and grains is present in the most recent sub-period (please refer to the Appendix). CPQS results reveal a much stronger commonality from 2004 to 2021, only significant in this period. Marshall et al. (2013) find similar results. They conclude that Proportional quoted spread (which is the high-frequency version of CPQS) has a non-significant concurrent market liquidity coefficient for the pre-financialization period, but after 2004, the coefficients become highly significant with a 0.176 average value. They also find that Amihud is a robust measure as it can show that commonality is present during both sub-periods.

Generally, we can conclude that the strength of commonality increased between sub-periods, as it became significant for more commodities (% + Significant). Three out of four average Adjusted R^2 are also higher in the most recent sub-period as well as all t-statistics.

Increased commonality can be explained by demand- or supply-side factors, as Marshall et al. (2013) state in their study. Cheng and Xiong (2014) note that since 2004 commodities have become just another asset class for investments and speculations. There has been a large inflow of capital from commodity index traders, which started the financialization of commodities. This phenomenon might be a demand-side explanation for the stronger commonality. The second sub-period also includes the global financial crisis, when the prices of many commodities have dropped. This is how stronger commonality could be explained from a supply-side perspective.

The results in Table 7 can give us an image of commodity liquidity commonality in a narrower sense, presenting whether commonality is significant in a given commodity family. As the commodities in the energy family are highly traded, we might think that liquidity co-movements are highest here. Our results show that agricultural commodities (grains and livestock) are the most sensitive to changes in market-wide liquidity. Sanders et al. (2010) find no shifts or trends in agricultural commodity futures speculation. The share of open interest from index traders has increased, but the agricultural futures market is mainly based on the participation of traditional commercial hedgers. This means that the surge in prices can be mainly explained by the growing amount of hedging activities, which provide a traditional, consistent and steady liquidity position.

Table 7 – Commonality in commodity families summarized by proxies

	Energy	Grains	Livestock	Metals
<i>Panel A: Amihud illiquidity ratio</i>				
Concurrent – coefficient	0.803***	0.467***	0.225**	0.492**
Concurrent – <i>t</i> -statistic	5.343	11.103	7.157	6.183
Adjusted R ² mean	20.50%	15.32%	6.61%	16.87%
Adjusted R ² median	19.78%	15.07%	7.16%	18.45%
<i>Panel B: Volatility over Volume</i>				
Concurrent – coefficient	0.020	0.109	0.012	1.166
Concurrent – <i>t</i> -statistic	1.454	1.919	1.029	1.565
Adjusted R ² mean	20.24%	3.90%	20.03%	8.87%
Adjusted R ² median	20.15%	3.31%	16.83%	8.96%
<i>Panel C: Closing Percent Quoted Spread</i>				
Concurrent – coefficient	0.002	0.673**	0.064**	0.347
Concurrent – <i>t</i> -statistic	0.070	6.971	13.309	3.179
Adjusted R ² mean	0.20%	3.72%	1.92%	1.10%
Adjusted R ² median	0.13%	4.05%	2.32%	0.99%
<i>Panel D: High-Low spread estimator</i>				
Concurrent – coefficient	1.098***	0.644***	0.295**	0.490**
Concurrent – <i>t</i> -statistic	4.209	12.636	8.539	9.937
Adjusted R ² mean	18.21%	13.07%	9.71%	10.11%
Adjusted R ² median	16.85%	13.32%	8.19%	9.80%

We report the market-model cross-sectional averages of the market liquidity coefficients and related *t*-stats. We use data for the 1 January 2000 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables. We average the individual coefficients within each commodity family using the groups from Table 1. We also report cross-sectional averages and medians of Adjusted R². *, **, *** denote significance at 10%, 5% and 1% level respectively.

The Amihud and CSA proxies are the most robust liquidity measures again, as they show that market-wide liquidity influences individual liquidity in all commodity families. VoV has very low coefficients, which do not prove to be statistically significant.

4.1.3. Supply-side liquidity commonality

Table 8 – Supply-side explanations summarized by proxies

	Amihud	VoV	CPQS	CSA
$\Delta L_{M,i,t}$	0.583***	0.246	0.270***	0.737***
<i>t</i> -statistic	6.750	1.309	3.401	5.789
$\Delta L_{M,i,t} D_{down,M,i,t}$	0.293***	-0.468	-0.184***	0.058
<i>t</i> -statistic	2.982	-1.067	-3.096	0.564
Adjusted R ²	12.52%	5.10%	2.24%	12.68%

Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). We use data for the 1 January 2000 - 31 December 2021 period. $\Delta L_{M,i,t}$ is the coefficient of concurrent market-liquidity change. $\Delta L_{M,i,t} D_{down,M,i,t}$ is a coefficient of an interaction term, where $D_{down,M,i,t}$ is a dummy variable that equals one if $R_{M,i,t}$ is below its conditional mean with more than 1.5 standard deviations. *, **, *** denote significance at 10%, 5% and 1% level respectively.

The supply-side regression has a similar structure as the market model. Both try to explain individual liquidity changes with market-wide liquidity changes and control variables. This regression also includes interaction variables to look for the effects of market declines. Table 8 does not reveal unanimous results. $\Delta L_{M,i,t} D_{down,M,i,t}$ is statistically significant and positive only when using Amihud as a proxy. We can conclude that market declines increase the market liquidity coefficient from 0.583 to 0.876 in this case. Our results regarding the Amihud measure are very similar to the coefficients in Hameed et al. (2010). They also use daily data to construct adjusted spreads as liquidity proxies. They find that the market liquidity coefficient increases from 0.56 to 0.87 during market-wide return drops. Marshall et al. (2013) also approach commonality from this perspective. The interaction variable's coefficient when using the Amihud measure does not prove to be significant in their case. They conclude that there is weak evidence to support the claim that market declines significantly influence individual liquidity.

4.2. THE IMPACT OF OPEC ANNOUNCEMENTS ON LIQUIDITY COMMONALITY IN ENERGY MARKETS

This section introduces results which have not been researched in connection with liquidity commonality. We test whether there is connection between OPEC announcements and

energy liquidity commonality. We use the methodology detailed in Subsection 3.4. In this section, we are only looking at the energy market, as OPEC has an authority to influence production levels in the oil markets.

Table 9 – Impact of OPEC announcements

	Amihud	VoV	CPQS	CSA
Coefficient	0.163*	0.378***	0.033	-0.005
<i>t</i> -statistic	1.724	3.574	0.376	0.047

We present the coefficients of the announcement dummy variables, as well as related *t*-stats. We regress time-varying commonality measures on the announcement dummy that equals one during a three-day event window (previous, concurrent and next trading days). *, **, *** denote significance at 10%, 5% and 1% level respectively.

First, we regress the time-varying commonality term $\bar{\beta}_{L,t}$ on the dummy variable that represents all announcements. Table 9 presents the results of our regressions. Surprisingly, announcements have a significantly positive effect on liquidity commonality when using Volatility over Volume. Amihud also has a positive and significant coefficient at a 10% significance level. This means that on days surrounding OPEC announcements, liquidity co-movements are stronger.

Table 10 – Impact of classified OPEC announcements

	Amihud	VoV	CPQS	CSA
INC - coefficient	0.185	0.614**	0.082	0.135
<i>t</i> -statistic	0.774	2.291	0.374	0.541
FTA - coefficient	0.132	0.300	-0.563***	-0.105
<i>t</i> -statistic	0.675	1.370	3.134	0.515
ATM - coefficient	0.385***	0.312*	0.154	0.100
<i>t</i> -statistic	2.589	1.866	1.125	0.648
CUT - coefficient	-0.207	0.415*	0.385**	-0.179
<i>t</i> -statistic	1.058	1.896	2.144	0.882

We present the coefficients of the dummy variables for each announcement classification, as well as related *t*-stats. We regress time-varying commonality measures on the announcement dummies that equal one during a three-day event window (previous, concurrent and next trading days). *, **, *** denote significance at 10%, 5% and 1% level respectively.

We further test how different classifications of OPEC announcements affect daily time-varying commonality measures. The results in Table 10 are not consequent, but they reveal that announcements generally have an impact on energy liquidity co-movements. Volatility

over Volume is again the proxy that shows us significant dependencies between announcements and liquidity co-movements. All announcements are significant at a 10% significance level by at least one of the liquidity proxies.

Spencer and Bredin (2019) find that announcement effects on the term structure level are similar to the effects on prices. CUT announcements have negative, INC decisions have positive impacts (Demirer and Kutan, 2010; Lin and Tamvakis, 2010; Loutia et al., 2016). Our results show that in the case of statistically significant INC or CUT coefficients, they both influence liquidity commonality positively.

We can see that the market differentiates between the two announcements, after which no change is followed. When we use CPQS, we can conclude that the meetings, at which the countries fail to agree, have a negative impact on liquidity commonality. This result is similar to the discovery by Spencer and Bredin (2019). They highlight that ATM and FTA announcements have very different impacts on the term structure (slope and curvature) of WTI crude oil futures. Their results regarding the slope factor imply that markets are more pessimistic following FTA decisions, expecting that prices will fall or rise by less. The curvature factor determines the speed of adjustment of short-run prices to long-run equilibrium. After INC announcements is this adjustment the fastest. A slowing in the speed of adjustment can be observed following FTA announcements compared to ATM decisions. Markets are more cautious when the OPEC countries fail to agree on production levels. Language is important when announcing OPEC decisions.

5. CONCLUSIONS AND IMPLICATIONS FOR FUTURE WORK

In this study, we approach liquidity commonality in the commodity futures market from different perspectives. We use four liquidity measures, two Price Impact-Based (Amihud illiquidity measure, Volatility over Volume) and two Transaction Cost-Based (Closing Percent Quoted Spread, High-Low Spread Estimator) low-frequency proxies. We examine 16 commodities from the S&P GSCI Commodity Index, which span across all commodity families. Our first conclusion is that liquidity co-movements are significant in the commodity futures market during the sample period (2000-2021). The commonality is robust to different liquidity proxies. Liquidity measured with the Amihud and CSA proxies is the most sensitive to changes in market-wide liquidity.

For a more thorough investigation, other liquidity measures could be included. Barardehi et al. (2019) introduce a version of Amihud measure, which is adjusted for overnight returns. They prove that it explains the cross-section of expected (risk-adjusted) returns better than the original one. Bedowska-Sójka and Kliber (2019) also introduce a High-Low Range measure, where they replace the bid and ask prices in the Closing Percent Quoted Spread with high and low prices. Further studies could also implement these proxies for a more robust investigation.

Our study finds that Amihud and High-Low spread estimator are the most robust proxies when analysing liquidity commonality, as they present significant co-movements across all commodity families, and could capture pre-financialization commonality too. Using Amihud, we could also show evidence of increased liquidity commonality during market declines. The coefficients when using VoV are usually non-significant, because the daily estimators are very low. We suggest using a logarithmic transformation on the volume denominator instead of taking the square root.

Although commonality already existed before 2004, commodity financialization increased the strength of liquidity co-movements, as they became (more) significant for more commodities. The Amihud ratio and the High-Low Spread Estimator could capture this pre-financialization liquidity commonality the best. Commonality is strongest in the grains commodity family, as all proxies in both sub-periods could capture this phenomenon. As our pre-financialization period is short, other studies could source data for longer periods,

e.g. from 1990 until 2022. The effects of commodity financialization could also be further researched, when analysing the behaviour of liquidity commonality.

There is some evidence to support the idea that market declines increase commodity liquidity commonality, but it is weak considering that only Amihud could present significant coefficients.

We find evidence that OPEC announcements have a significant impact on liquidity commonality in the energy market. Using a three-day event window (-1, +1) we conclude that the co-movements around meetings increase. We find some evidence, when using Closing Percent Quoted Spread, that liquidity commonality around meetings decreases where the participants fail to agree. Further research could include testing the impacts of other announcements. Demirer and Kutan (2010) also examine the impacts of US Strategic Petroleum Reserve (SPR) announcements in crude oil spot and futures returns. These decisions might have an impact in the energy market, which could be further investigated. Sensoy et al. (2021) find that Federal Open Market Committee (FOMC) announcements have a significant effect on the FX market liquidity co-movements. Further studies could use these announcements as control variables in addition to the OPEC announcements.

REFERENCES

- Acharya, V., & Pedersen, L. (2005). Asset pricing with liquidity risk. *Journal of Financial Economics*, 77 (2), 375–410.
- Adams, Z., Collot, S., & Kartsakli, M. (2020). Have commodities become a financial asset? Evidence from ten years of Financialization. *Energy Economics*, 89, 104769.
- Amihud, Y. (2002). Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets*, 5 (1), 31–56.
- Barardehi, Y., Bernhardt, D., Ruchti, T., & Weidenmier, M. D. (2019). The Night and Day of Amihud's (2002) Liquidity Measure. *SSRN Electronic Journal*.
- Bedowska-Sójka, B., & Kliber, A. (2019). The causality between liquidity and volatility in the Polish stock market. *Finance Research Letters*, 30, 110–115.
- Brockman, P., Chung, D. Y., & Pérignon, C. (2009). Commonality in Liquidity: A Global Perspective. *Journal of Financial and Quantitative Analysis*, 44 (4), 851–882.
- Cheng, I. H., & Xiong, W. (2014). Financialization of Commodity Markets. *Annual Review of Financial Economics*, 6 (1), 419–441.
- Chordia, T., Roll, R., & Subrahmanyam, A. (2000). Commonality in liquidity. *Journal of Financial Economics*, 56 (1), 3–28.
- Chordia, T., Sarkar, A., & Subrahmanyam, A. (2004). An Empirical Analysis of Stock and Bond Market Liquidity. *Review of Financial Studies*, 18 (1), 85–129.
- Chung, K. H., & Zhang, H. (2014). A simple approximation of intraday spreads using daily data. *Journal of Financial Markets*, 17, 94–120.
- Corwin, S. A., & Schultz, P. (2012). A Simple Way to Estimate Bid-Ask Spreads from Daily High and Low Prices. *The Journal of Finance*, 67 (2), 719–760.
- Demirer, R., & Kutan, A. M. (2010). The behavior of crude oil spot and futures prices around OPEC and SPR announcements: An event study perspective. *Energy Economics*, 32 (6), 1467–1476.
- Ding, S., Cui, T., Zheng, D., & Du, M. (2021). The effects of commodity financialization on commodity market volatility. *Resources Policy*, 73, 102220.
- Fong, K. Y. L., Holden, C. W., & Tobek, O. (2018). Are Volatility Over Volume Liquidity Proxies Useful for Global or US Research? *Kelley School of Business Research Paper No. 17–49*.
- Fong, K. Y. L., Holden, C. W., & Trzcinka, C. A. (2017). What Are the Best Liquidity Proxies for Global Research? *Review of Finance*, 21 (4), 1355–1401.
- Garman, M. B., & Klass, M. J. (1980). On the Estimation of Security Price Volatilities from Historical Data. *The Journal of Business*, 53 (1), 67.
- Goyenko, R. Y., Holden, C. W., & Trzcinka, C. A. (2009). Do liquidity measures measure liquidity? *Journal of Financial Economics*, 92 (2), 153–181.
- Hameed, A., Kang, W., & Viswanathan, S. (2010). Stock Market Declines and Liquidity. *The Journal of Finance*, 65 (1), 257–293.
- Hasbrouck, J., & Seppi, D. J. (2001). Common factors in prices, order flows, and liquidity. *Journal of Financial Economics*, 59 (3), 383–411.
- Irwin, S. H., & Sanders, D. R. (2012). Financialization and Structural Change in Commodity Futures Markets. *Journal of Agricultural and Applied Economics*, 44 (3), 371–396.
- Karolyi, G. A., Lee, K. H., & van Dijk, M. A. (2012). Understanding commonality in liquidity around the world. *Journal of Financial Economics*, 105 (1), 82–112.

- Karstanje, D., van der Wel, M., & van Dijk, D. J. C. (2015). Common Factors in Commodity Futures Curves. *SSRN Electronic Journal*.
- Klein, T. (2018). Trends and contagion in WTI and Brent crude oil spot and futures markets - The role of OPEC in the last decade. *Energy Economics*, 75, 636–646.
- Korajczyk, R. A., & Sadka, R. (2008). Pricing the commonality across alternative measures of liquidity. *Journal of Financial Economics*, 87 (1), 45–72.
- Le, H., & Gregoriou, A. (2020). How do you capture liquidity? A review of the literature on low-frequency stock liquidity. *Journal of Economic Surveys*, 34 (5), 1170–1186.
- Lin, S. X., & Tamvakis, M. (2010). OPEC announcements and their effects on crude oil prices. *Energy Policy*, 38 (2), 1010–1016.
- Loutia, A., Mellios, C., & Andriosopoulos, K. (2016). Do OPEC announcements influence oil prices? *Energy Policy*, 90, 262–272.
- Main, S., Irwin, S. H., Sanders, D. R., & Smith, A. (2018). Financialization and the returns to commodity investments. *Journal of Commodity Markets*, 10, 22–28.
- Mancini, L., Rinaldo, A., & Wrampelmeyer, J. (2013). Liquidity in the Foreign Exchange Market: Measurement, Commonality, and Risk Premiums. *The Journal of Finance*, 68 (5), 1805–1841.
- Marshall, B. R., Nguyen, N. H., & Visaltanachoti, N. (2013). Liquidity commonality in commodities. *Journal of Banking & Finance*, 37 (1), 11–20.
- Pástor, L., & Stambaugh, R. F. (2001). Liquidity Risk and Expected Stock Returns. *SSRN Electronic Journal*.
- Richter, T. J. (2022). Liquidity commonality in sovereign bond markets. *International Review of Economics & Finance*, 78, 501–518.
- Sanders, D. R., Irwin, S. H., & Merrin, R. P. (2010). The Adequacy of Speculation in Agricultural Futures Markets: Too Much of a Good Thing? *Applied Economic Perspectives and Policy*, 32 (1), 77–94.
- Schmidbauer, H., & Rösch, A. (2012). OPEC news announcements: Effects on oil price expectation and volatility. *Energy Economics*, 34 (5), 1656–1663.
- Sensoy, A. (2016). Commonality in liquidity: Effects of monetary policy and macroeconomic announcements. *Finance Research Letters*, 16, 125–131.
- Sensoy, A., Uzun, S., & Lucey, B. M. (2021). Commonality in FX liquidity: High-frequency evidence. *Finance Research Letters*, 39, 101577.
- Spencer, S., & Bredin, D. (2019). Agreement matters: OPEC announcement effects on WTI term structure. *Energy Economics*, 80, 589–609.

MELLÉKLETEK

1. MELLÉKLET: LIQUIDITY SENSITIVITY TO THE CHANGES IN MARKET-WIDE LIQUIDITY - VOLATILITY OVER VOLUME

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.001 (0.14)	0.003 (0.32)	0.019** (2.04)	0.000 (-0.82)	0.000 (0.96)	0.000 (-0.28)	0.000* (-1.70)	0.001*** (18.01)	0.000* (-1.71)
WTI crude oil	-0.005 (-0.95)	0.008 (1.39)	-0.012** (-2.39)	0.000 (-0.24)	0.000 (1.19)	0.000 (-1.09)	0.000** (-2.26)	0.001*** (41.64)	0.000 (0.31)
Gasoil	0.000 (-0.03)	0.003 (0.96)	0.000 (0.08)	0.000 (-0.54)	0.000 (0.62)	0.000 (0.13)	0.000** (-2.09)	0.000*** (35.08)	0.000 (-0.07)
Natural gas	0.030 (0.70)	0.087* (1.83)	-0.120*** (-2.81)	0.000 (0.20)	0.000 (-0.85)	0.000 (-0.61)	0.000 (-0.18)	0.003*** (26.82)	0.000 (-0.19)
Gasoline	-0.003 (-0.40)	0.002 (0.30)	-0.006 (-0.97)	0.000 (1.43)	0.000** (-2.48)	0.000 (1.41)	0.000 (-1.27)	0.001*** (33.42)	0.000*** (3.27)
Heating oil	-0.017 (-1.52)	0.015 (1.27)	-0.006 (-0.55)	0.000 (1.24)	0.000 (0.08)	0.000* (-1.95)	0.000 (0.14)	0.001*** (19.64)	0.000 (-1.43)
Com	-0.017 (-1.39)	-0.004 (-0.28)	-0.005 (-0.46)	0.000 (-0.63)	0.000 (0.34)	0.000 (-0.33)	0.000 (0.27)	0.001*** (15.33)	0.000 (-0.47)
Chicago wheat	0.040* (1.76)	0.088*** (3.52)	-0.002 (-0.08)	0.000 (0.70)	0.000 (-0.15)	0.000 (-0.06)	0.000 (-1.07)	0.001*** (8.29)	0.000 (-0.83)
Kansas wheat	0.028 (0.62)	0.310*** (6.21)	0.145*** (3.26)	0.000 (-0.23)	0.000* (1.71)	0.000 (0.13)	0.000 (-0.69)	0.002*** (8.39)	-0.001*** (-4.20)
Soybean	0.006 (0.40)	0.041*** (2.60)	0.043*** (3.01)	0.000 (-0.06)	0.000 (0.39)	0.000 (-0.02)	0.000 (0.86)	0.001*** (10.42)	0.000 (1.21)
Lean hogs	0.023*** (2.71)	0.030*** (3.26)	0.015* (1.76)	0.000 (-0.72)	0.000* (1.87)	0.000 (-0.71)	0.000 (-0.07)	0.002*** (41.61)	0.000 (0.84)
Live cattle	-0.047** (-2.48)	-0.022 (-1.03)	-0.001 (-0.05)	0.000 (-0.34)	0.000 (0.28)	0.000 (-0.46)	0.000*** (3.45)	0.003*** (21.58)	0.000* (1.87)
Feeder cattle	0.006 (0.47)	0.029** (2.18)	0.007 (0.55)	0.000 (-0.05)	0.000 (0.78)	0.000 (-0.97)	0.000 (-0.06)	0.003*** (27.15)	0.000 (-0.53)
Gold	-0.016 (-1.09)	0.027* (1.66)	0.008 (0.56)	0.000* (-1.77)	0.000 (0.07)	0.000 (-0.09)	0.000*** (-4.94)	0.001*** (14.86)	0.000*** (-3.07)
Silver	0.773 (1.58)	3.273*** (5.98)	0.494 (1.01)	0.000 (0.61)	0.000 (-0.93)	0.000 (0.49)	-0.002*** (-3.64)	0.010*** (13.64)	-0.003*** (-4.12)
Copper	0.023 (1.07)	0.200*** (8.51)	0.045** (2.15)	0.000 (-0.84)	0.000 (0.96)	0.000 (-0.15)	0.000 (-0.90)	0.002*** (16.23)	0.000 (-0.14)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2000 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

2. MELLÉKLET: LIQUIDITY SENSITIVITY TO THE CHANGES IN MARKET-WIDE LIQUIDITY - CLOSING PERCENT QUOTED SPREAD

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.050*	0.047*	-0.029	-0.024*	-0.002	0.003	-0.027	-0.023	-0.018
	(1.89)	(1.76)	(-1.09)	(-1.70)	(-0.16)	(0.21)	(-1.16)	(-0.89)	(-0.78)
WTI crude oil	-0.024	0.003	-0.005	0.002	0.005	-0.022	0.046*	0.162***	0.137***
	(-0.70)	(0.08)	(-0.16)	(0.09)	(0.27)	(-1.19)	(1.70)	(5.62)	(5.10)
Gasoil	0.012	0.040	0.033	0.009	-0.007	-0.028**	0.004	0.011	0.021
	(0.50)	(1.62)	(1.36)	(0.71)	(-0.53)	(-2.14)	(0.19)	(0.45)	(0.98)
Natural gas	-0.028	0.057	-0.072	0.000	-0.021	-0.006	-0.028	-0.118***	-0.079**
	(-0.58)	(1.15)	(-1.47)	(0.01)	(-0.80)	(-0.22)	(-0.87)	(-3.27)	(-2.43)
Gasoline	-0.034	-0.018	-0.013	-0.008	0.027**	-0.006	-0.007	0.044	-0.030
	(-1.46)	(-0.76)	(-0.55)	(-0.64)	(2.19)	(-0.50)	(-0.26)	(1.42)	(-1.06)
Heating oil	-0.093**	-0.118***	-0.018	-0.033	0.031	0.009	-0.068	0.062	-0.028
	(-2.09)	(-2.61)	(-0.40)	(-1.38)	(1.29)	(0.39)	(-1.59)	(1.29)	(-0.66)
Corn	0.077**	0.544***	0.083**	0.003	-0.038**	-0.058***	0.081**	0.038	0.035
	(2.33)	(16.34)	(2.53)	(0.17)	(-2.24)	(-3.40)	(2.30)	(0.98)	(0.99)
Chicago wheat	0.032	0.893***	0.128**	-0.019	-0.108***	0.004	-0.147***	-0.276***	-0.143***
	(0.57)	(15.62)	(2.27)	(-0.68)	(-3.87)	(0.16)	(-2.68)	(-4.55)	(-2.61)
Kansas wheat	0.147**	0.851***	0.175**	0.021	-0.074**	-0.017	-0.124*	-0.479***	-0.321***
	(2.16)	(12.25)	(2.56)	(0.63)	(-2.22)	(-0.52)	(-1.90)	(-6.61)	(-4.90)
Soybean	0.088**	0.406***	0.049	-0.004	-0.050**	-0.050**	0.102**	-0.079	0.023
	(2.25)	(10.27)	(1.25)	(-0.22)	(-2.47)	(-2.46)	(1.98)	(-1.37)	(0.45)
Lean hogs	-0.009	0.076**	-0.027	-0.013	-0.001	-0.002	0.030	0.159***	-0.073
	(-0.26)	(2.22)	(-0.81)	(-0.70)	(-0.04)	(-0.11)	(0.62)	(2.90)	(-1.48)
Live cattle	-0.016	0.052**	-0.042**	0.002	0.052***	-0.031***	0.061	0.299***	-0.071*
	(-0.78)	(2.50)	(-2.02)	(0.15)	(4.75)	(-2.83)	(1.52)	(6.55)	(-1.76)
Feeder cattle	-0.010	0.064**	-0.024	0.016	-0.003	0.006	0.016	0.801***	0.079
	(-0.31)	(2.08)	(-0.78)	(1.02)	(-0.22)	(0.38)	(0.26)	(11.42)	(1.23)
Gold	-0.174*	0.041	-0.169*	-0.072	-0.135	-0.003	0.218	-0.123	-0.190
	(-1.91)	(0.44)	(-1.85)	(-0.87)	(-1.63)	(-0.04)	(1.56)	(-0.79)	(-1.35)
Silver	-0.044	0.536***	-0.095	0.028	-0.072**	-0.039	-0.111*	-0.432***	-0.300***
	(-0.66)	(8.07)	(-1.44)	(0.84)	(-2.17)	(-1.18)	(-1.96)	(-6.87)	(-5.28)
Copper	-0.010	0.462***	0.070	-0.030	-0.031	0.017	-0.231***	0.072	-0.164*
	(-0.15)	(6.34)	(0.97)	(-0.84)	(-0.84)	(0.47)	(-2.76)	(0.77)	(-1.96)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2000 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

3. MELLÉKLET: LIQUIDITY SENSITIVITY TO THE CHANGES IN MARKET-WIDE LIQUIDITY - HIGH-LOW SPREAD ESTIMATOR

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.036 (0.88)	1.203*** (26.22)	0.029 (0.73)	0.017 (1.53)	-0.025** (-2.21)	0.009 (0.77)	0.065*** (3.43)	0.217*** (10.40)	0.131*** (6.90)
WTI crude oil	0.004 (0.08)	1.837*** (33.20)	-0.081* (-1.66)	0.017 (1.33)	-0.010 (-0.80)	0.008 (0.63)	-0.061*** (-3.10)	0.277*** (13.05)	0.158*** (8.01)
Gasoil	0.114*** (3.27)	0.812*** (20.54)	-0.035 (-1.00)	0.004 (0.37)	-0.018* (-1.82)	0.020** (2.00)	0.002 (0.12)	0.190*** (10.27)	0.134*** (8.14)
Natural gas	-0.010 (-0.15)	1.082*** (15.23)	-0.034 (-0.55)	-0.021 (-1.23)	0.034** (1.99)	-0.015 (-0.88)	0.024 (1.07)	0.203*** (8.18)	0.225*** (10.07)
Gasoline	0.124*** (5.90)	0.035 (1.45)	0.019 (0.91)	0.012* (1.86)	0.003 (0.51)	0.001 (0.15)	0.011 (0.75)	0.173*** (10.90)	0.170*** (11.74)
Heating oil	-0.092** (-2.35)	1.618*** (36.71)	0.030 (0.77)	-0.017 (-1.62)	0.028*** (2.65)	0.011 (1.03)	-0.002 (-0.10)	0.130*** (5.95)	0.107*** (5.56)
Corn	-0.076** (-2.46)	0.544*** (15.56)	-0.020 (-0.65)	0.007 (0.79)	-0.007 (-0.75)	-0.003 (-0.29)	-0.004 (-0.21)	0.169*** (7.91)	0.091*** (4.77)
Chicago wheat	-0.034 (-0.96)	0.776*** (19.39)	-0.082** (-2.31)	-0.009 (-0.90)	0.006 (0.63)	-0.001 (-0.09)	0.023 (1.15)	0.198*** (8.80)	0.122*** (6.00)
Kansas wheat	-0.046 (-1.48)	0.725*** (20.86)	-0.085*** (-2.76)	-0.001 (-0.15)	-0.001 (-0.09)	0.007 (0.83)	0.022 (1.26)	0.214*** (10.85)	0.130*** (7.26)
Soybean	-0.071*** (-2.80)	0.531*** (18.46)	-0.037 (-1.44)	0.002 (0.27)	0.001 (0.14)	0.009 (1.25)	0.018 (0.93)	0.207*** (9.56)	0.111*** (5.78)
Lean hogs	0.035 (1.44)	0.371*** (13.47)	0.012 (0.49)	-0.003 (-0.48)	-0.002 (-0.28)	0.009 (1.28)	0.013 (0.66)	0.252*** (11.34)	0.143*** (7.15)
Live cattle	-0.009 (-0.53)	0.311*** (16.60)	-0.026 (-1.59)	0.002 (0.37)	-0.001 (-0.25)	0.001 (0.14)	0.008 (0.45)	0.285*** (13.78)	0.242*** (13.23)
Feeder cattle	-0.015 (-0.99)	0.204*** (12.11)	-0.021 (-1.41)	0.002 (0.53)	-0.005 (-1.08)	0.001 (0.24)	0.031* (1.75)	0.251*** (12.84)	0.149*** (8.35)
Gold	0.004 (0.24)	0.351*** (17.60)	0.012 (0.67)	-0.013 (-1.37)	0.057*** (6.02)	-0.038*** (-4.01)	0.032* (1.96)	0.200*** (11.14)	0.081*** (4.99)
Silver	-0.034 (-1.08)	0.561*** (15.96)	-0.001 (-0.05)	-0.006 (-0.65)	0.008 (0.89)	-0.006 (-0.70)	0.010 (0.61)	0.150*** (8.50)	0.051*** (3.17)
Copper	-0.025 (-0.86)	0.559*** (16.67)	0.065** (2.21)	-0.003 (-0.38)	0.003 (0.33)	-0.010 (-1.13)	-0.006 (-0.31)	0.212*** (9.25)	0.052** (2.55)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2000 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

4. MELLÉKLET: COMMONALITY IN LIQUIDITY - SUBPERIOD 1 - AMIHUD

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	-0.032 (-0.32)	0.961*** (8.33)	-0.003 (-0.03)	-0.003** (-1.97)	0.005*** (3.16)	-0.002 (-1.53)	-0.010** (-2.09)	0.045*** (8.35)	0.016*** (3.21)
WTI crude oil	0.065 (0.65)	1.491*** (12.90)	0.177* (1.76)	-0.002 (-1.14)	0.003** (2.25)	-0.002* (-1.76)	-0.015*** (-3.22)	0.039*** (7.15)	0.015*** (3.07)
Gasoil	0.135 (1.30)	0.671*** (5.61)	0.117 (1.13)	0.000 (-0.15)	0.001 (0.76)	-0.002 (-1.50)	-0.015** (-2.47)	0.044*** (6.13)	0.013** (2.16)
Natural gas	-0.176 (-0.73)	1.119*** (4.10)	0.009 (0.04)	0.003 (1.00)	-0.002 (-0.61)	-0.001 (-0.33)	-0.021*** (-3.40)	0.045*** (6.85)	0.010 (1.56)
Gasoline	0.131** (2.13)	0.011 (0.15)	0.048 (0.79)	-0.002** (-2.04)	0.002* (1.78)	-0.001 (-1.20)	-0.001 (-0.17)	0.014** (2.08)	0.018*** (3.11)
Heating oil	-0.086 (-0.68)	1.527*** (10.65)	0.309** (2.47)	0.000 (0.16)	-0.002 (-1.17)	0.004** (2.43)	0.009* (1.89)	0.023*** (4.25)	-0.002 (-0.35)
Corn	0.048 (0.92)	0.203*** (3.39)	-0.002 (-0.03)	0.000 (-0.16)	-0.003*** (-3.32)	0.002*** (2.99)	-0.002 (-0.39)	0.044*** (8.37)	0.003 (0.67)
Chicago wheat	-0.019 (-0.29)	0.336*** (4.58)	-0.171*** (-2.65)	0.001 (0.56)	-0.001 (-0.57)	0.002** (1.97)	-0.003 (-0.60)	0.047*** (8.62)	0.009* (1.90)
Kansas wheat	0.023 (0.33)	0.348*** (4.54)	-0.025 (-0.37)	0.000 (-0.18)	-0.001 (-1.38)	0.002** (2.14)	-0.024*** (-3.76)	0.043*** (6.20)	0.015** (2.38)
Soybean	-0.032 (-0.68)	0.197*** (3.66)	0.128*** (2.73)	0.000 (0.29)	-0.003*** (-3.88)	0.003*** (3.53)	-0.004 (-0.91)	0.041*** (7.58)	0.000 (0.03)
Lean hogs	0.175 (1.07)	0.329* (1.77)	-0.356** (-2.18)	0.002 (0.65)	0.000 (0.04)	-0.001 (-0.21)	-0.047*** (-2.91)	0.100*** (5.53)	0.048*** (2.95)
Live cattle	0.026 (0.44)	0.162** (2.46)	-0.045 (-0.78)	0.000 (-0.42)	-0.006*** (-6.23)	0.005*** (5.86)	0.034*** (3.86)	0.014 (1.41)	0.019** (2.21)
Feeder cattle	-0.089* (-1.96)	0.051 (0.99)	-0.054 (-1.18)	0.000 (0.48)	0.000 (-0.32)	0.000 (0.25)	-0.019** (-2.01)	0.063*** (6.33)	0.028*** (3.14)
Gold	-0.038 (-0.73)	0.239*** (4.09)	-0.041 (-0.80)	-0.005 (-1.10)	0.008 (1.54)	-0.001 (-0.18)	-0.006 (-1.02)	0.045*** (7.40)	0.021*** (3.83)
Silver	0.029 (0.28)	0.417*** (3.54)	-0.017 (-0.16)	-0.001 (-0.33)	-0.001 (-0.57)	0.001 (0.76)	-0.026*** (-2.75)	0.041*** (3.76)	0.017* (1.78)
Copper	0.037 (0.68)	0.166*** (2.65)	0.038 (0.69)	-0.002* (-1.83)	0.001 (1.31)	0.001 (1.11)	-0.013** (-2.04)	0.063*** (8.57)	-0.011* (-1.78)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2000 - 31 December 2003 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

5. MELLÉKLET: COMMONALITY IN LIQUIDITY - SUBPERIOD 2 - AMIHUD

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.062*	1.000***	0.074**	0.001	-0.001	0.003	-0.008***	0.042***	0.009***
	(1.72)	(23.79)	(2.05)	(0.46)	(-0.46)	(1.57)	(-4.27)	(21.27)	(4.84)
WTI crude oil	-0.001	1.118***	0.098**	0.000	0.001	0.000	0.000	0.038***	0.005***
	(-0.03)	(23.74)	(2.41)	(-0.13)	(0.47)	(-0.16)	(-0.20)	(19.94)	(3.02)
Gasoil	0.069*	0.618***	0.091**	0.002	0.002	-0.001	-0.001	0.020***	0.003*
	(1.90)	(14.58)	(2.50)	(1.49)	(1.24)	(-0.47)	(-0.42)	(9.87)	(1.77)
Natural gas	-0.065	0.632***	-0.040	-0.004	0.003	0.003	-0.016***	0.056***	-0.001
	(-0.89)	(7.50)	(-0.54)	(-1.20)	(0.94)	(0.84)	(-5.11)	(16.21)	(-0.46)
Gasoline	0.295***	0.237***	0.009	0.002	-0.004**	0.003*	0.002	0.048***	0.005**
	(7.63)	(5.23)	(0.23)	(1.18)	(-2.25)	(1.79)	(0.92)	(16.74)	(2.06)
Heating oil	-0.020	1.026***	0.008	0.003*	-0.002	0.003**	-0.007***	0.033***	0.006***
	(-0.54)	(24.23)	(0.23)	(1.81)	(-0.92)	(2.07)	(-3.18)	(13.57)	(2.82)
Corn	-0.064**	0.484***	-0.047	-0.004***	0.003**	0.002	0.006***	0.028***	0.005***
	(-2.08)	(13.53)	(-1.52)	(-2.92)	(2.18)	(1.16)	(3.34)	(13.11)	(2.70)
Chicago wheat	-0.088***	0.570***	-0.070**	-0.001	0.004**	-0.001	-0.010***	0.028***	0.004**
	(-2.59)	(14.57)	(-2.07)	(-0.87)	(2.24)	(-0.47)	(-4.86)	(12.82)	(2.18)
Kansas wheat	-0.080**	0.633***	-0.046	-0.001	0.003	0.000	-0.005**	0.019***	0.004**
	(-2.17)	(14.94)	(-1.25)	(-0.71)	(1.51)	(-0.08)	(-2.19)	(7.91)	(2.01)
Soybean	-0.063**	0.374***	-0.065**	0.000	0.000	-0.001	0.001	0.043***	0.005**
	(-2.46)	(12.64)	(-2.54)	(-0.30)	(0.26)	(-0.54)	(0.41)	(19.24)	(2.43)
Lean hogs	-0.019	0.261***	-0.257***	0.003	-0.007**	0.005*	-0.022***	0.073***	0.045***
	(-0.29)	(3.46)	(-3.90)	(1.06)	(-2.40)	(1.71)	(-4.09)	(12.26)	(8.43)
Live cattle	-0.026	0.279***	-0.006	0.001	0.000	-0.001	0.013***	0.025***	0.006**
	(-1.03)	(9.64)	(-0.24)	(0.67)	(0.37)	(-0.85)	(4.52)	(8.09)	(2.11)
Feeder cattle	-0.052**	0.149***	-0.050*	0.001	-0.002	0.000	-0.019***	0.035***	0.013***
	(-2.00)	(4.97)	(-1.94)	(0.46)	(-1.55)	(0.02)	(-6.12)	(10.43)	(4.16)
Gold	-0.017	0.335***	-0.056***	-0.003***	0.003**	-0.003**	-0.003*	0.043***	0.003
	(-0.82)	(13.87)	(-2.65)	(-2.96)	(2.41)	(-2.35)	(-1.73)	(19.79)	(1.48)
Silver	-0.027	0.760***	-0.120*	0.002	0.000	0.000	-0.003	0.053***	0.007**
	(-0.43)	(10.64)	(-1.93)	(0.65)	(-0.05)	(-0.12)	(-1.14)	(15.77)	(2.31)
Copper	-0.011	0.525***	0.020	-0.001	0.003**	-0.002	-0.001	0.048***	0.000
	(-0.33)	(13.35)	(0.59)	(-0.49)	(2.01)	(-1.25)	(-0.54)	(18.60)	(-0.21)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2004 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

6. MELLÉKLET: COMMONALITY IN LIQUIDITY - SUBPERIOD 1 - VOLATILITY OVER

VOLUME

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.032 (1.09)	-0.020 (-0.63)	0.069** (2.37)	0.000 (-0.49)	0.000 (0.28)	0.000 (-0.05)	0.000 (-1.43)	0.001*** (9.83)	0.000 (-0.39)
WTI crude oil	0.010 (1.01)	0.025** (2.32)	-0.004 (-0.43)	0.000 (-0.42)	0.000 (-0.11)	0.000 (0.19)	0.000 (-1.18)	0.001*** (20.36)	0.000 (0.61)
Gasoil	0.004 (0.35)	0.004 (0.34)	0.007 (0.71)	0.000 (0.01)	0.000 (-0.39)	0.000 (0.03)	0.000* (-1.72)	0.001*** (14.81)	0.000 (1.16)
Natural gas	0.032 (0.26)	0.079 (0.58)	-0.059 (-0.47)	0.000 (0.17)	0.000 (-0.13)	0.000 (-0.15)	0.000 (-0.76)	0.004*** (10.84)	0.000 (-0.78)
Gasoline	-0.002* (-1.80)	0.001 (0.60)	0.001 (0.87)	0.000 (-0.21)	0.000 (1.64)	0.000 (-0.97)	0.000 (-0.47)	0.000*** (31.67)	0.000 (1.26)
Heating oil	-0.004 (-0.11)	0.041 (1.00)	-0.017 (-0.46)	0.000 (0.79)	0.000 (0.08)	0.000 (-0.65)	0.000 (0.72)	0.001*** (7.53)	0.000 (-1.50)
Corn	-0.101** (-2.53)	-0.105** (-2.44)	-0.070* (-1.76)	0.000 (-0.11)	0.000 (0.13)	0.000 (0.13)	-0.001* (-1.89)	0.001*** (3.61)	0.000 (-0.50)
Chicago wheat	-0.052* (-1.74)	0.013 (0.39)	-0.072** (-2.39)	0.000 (0.77)	0.000 (0.18)	0.000 (0.11)	0.000 (-0.37)	0.001*** (5.14)	0.000 (-1.35)
Kansas wheat	0.093 (0.99)	0.728*** (7.07)	0.061 (0.64)	0.000 (-0.04)	0.000 (0.04)	0.000 (0.23)	0.000 (0.34)	0.004*** (4.93)	0.001 (1.33)
Soybean	-0.002 (-0.08)	0.007 (0.22)	0.055* (1.79)	0.000 (-0.40)	0.000 (0.21)	0.000 (0.05)	0.000 (0.02)	0.001*** (4.32)	0.000 (-1.30)
Lean hogs	0.024 (1.44)	0.059*** (3.22)	0.009 (0.52)	0.000 (0.29)	0.000 (0.14)	0.000 (-0.06)	0.000 (0.59)	0.003*** (18.76)	0.000* (-1.84)
Live cattle	-0.014 (-1.34)	0.012 (1.11)	0.010 (0.99)	0.000 (-0.40)	0.000 (-0.17)	0.000 (-0.32)	0.000 (1.61)	0.003*** (22.78)	0.000* (1.74)
Feeder cattle	-0.004 (-0.24)	0.051** (2.54)	0.022 (1.20)	0.000 (0.18)	0.000 (0.16)	0.000 (0.01)	0.000 (0.32)	0.005*** (15.57)	-0.001* (-1.94)
Gold	-0.026 (-0.66)	-0.023 (-0.54)	0.042 (1.07)	0.000 (-1.47)	0.001** (2.22)	0.000 (0.01)	-0.001*** (-3.22)	0.003*** (8.46)	0.000 (-1.31)
Silver	0.314 (0.27)	4.085*** (3.23)	0.529 (0.46)	0.000 (-0.38)	0.000 (0.49)	0.000 (0.17)	0.001 (0.19)	0.019*** (4.87)	-0.005 (-1.30)
Copper	-0.015 (-0.52)	0.106*** (3.31)	0.028 (0.96)	0.000 (-0.33)	0.000 (0.98)	0.000 (0.12)	0.000 (-1.02)	0.003*** (9.34)	0.000 (0.68)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2000 - 31 December 2003 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

7. MELLÉKLET: COMMONALITY IN LIQUIDITY - SUBPERIOD 2 - VOLATILITY OVER VOLUME

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	-0.013*	0.009	-0.005	0.000	0.000	0.000	0.000	0.000***	0.000**
	(-1.76)	(1.03)	(-0.63)	(-0.07)	(-0.56)	(-0.98)	(-0.83)	(17.31)	(-2.40)
WTI crude oil	-0.014**	-0.006	-0.019***	0.000	0.000	0.000**	0.000	0.001***	0.000
	(-2.44)	(-0.95)	(-3.39)	(0.76)	(0.87)	(-2.31)	(-0.78)	(37.35)	(0.99)
Gasoil	-0.002	0.002	-0.004**	0.000	0.000	0.000	0.000	0.000***	0.000
	(-1.06)	(1.08)	(-2.44)	(0.22)	(-0.44)	(-0.72)	(-0.77)	(55.22)	(-0.70)
Natural gas	0.014	0.084*	-0.151***	0.000	0.000	0.000	0.000	0.003***	0.000
	(0.36)	(1.85)	(-3.75)	(-0.18)	(-1.64)	(-0.85)	(0.54)	(26.18)	(0.58)
Gasoline	-0.002	0.000	-0.009	0.000**	0.000***	0.000**	0.000	0.001***	0.000***
	(-0.22)	(-0.03)	(-1.03)	(2.33)	(-3.69)	(2.13)	(-1.49)	(31.08)	(2.79)
Heating oil	-0.026***	0.007	-0.003	0.000	0.000	0.000	0.000	0.001***	0.000
	(-3.78)	(0.94)	(-0.48)	(-0.58)	(-0.08)	(0.39)	(-1.44)	(24.81)	(1.59)
Corn	0.038***	0.064***	0.041***	0.000	0.000*	0.000	0.000***	0.001***	0.000
	(4.34)	(6.46)	(4.72)	(-1.62)	(1.93)	(-1.24)	(2.62)	(23.49)	(-0.41)
Chicago wheat	0.094***	0.142***	0.042	0.000	0.000	0.000	0.000	0.001***	0.000
	(3.18)	(4.26)	(1.42)	(0.46)	(-0.10)	(-0.14)	(-1.01)	(7.06)	(-0.47)
Kansas wheat	-0.020	0.119**	0.168***	0.000	0.000**	0.000	0.000	0.001***	-0.001***
	(-0.38)	(2.02)	(3.25)	(-0.25)	(2.57)	(0.00)	(-0.68)	(7.39)	(-5.18)
Soybean	0.015	0.061***	0.039**	0.000	0.000	0.000	0.000	0.001***	0.000**
	(0.90)	(3.29)	(2.34)	(0.03)	(0.99)	(-0.47)	(1.00)	(9.73)	(2.11)
Lean hogs	0.020**	0.015	0.008	0.000	0.000***	0.000	0.000	0.002***	0.000*
	(2.02)	(1.37)	(0.86)	(-1.50)	(2.64)	(-0.84)	(-0.50)	(38.43)	(1.89)
Live cattle	-0.068***	-0.043	-0.011	0.000	0.000	0.000	0.000***	0.003***	0.000*
	(-2.61)	(-1.47)	(-0.42)	(-0.44)	(0.41)	(-0.61)	(3.22)	(18.58)	(1.65)
Feeder cattle	0.013	0.019	0.002	0.000	0.000	0.000	0.000	0.002***	0.000
	(0.83)	(1.10)	(0.14)	(-0.09)	(0.99)	(-1.41)	(-0.15)	(24.03)	(-0.05)
Gold	-0.007	0.055***	-0.006	0.000	0.000*	0.000	0.000***	0.001***	0.000***
	(-0.47)	(3.40)	(-0.42)	(-1.09)	(-1.78)	(-0.22)	(-3.98)	(12.88)	(-3.03)
Silver	1.054*	2.873***	0.467	0.001**	-0.002***	0.000	-0.002***	0.009***	-0.002***
	(1.93)	(4.72)	(0.86)	(2.10)	(-2.99)	(0.63)	(-4.08)	(13.41)	(-4.02)
Copper	0.051*	0.258***	0.068**	0.000	0.000	0.000	0.000	0.002***	0.000
	(1.86)	(8.36)	(2.50)	(-0.46)	(-0.02)	(0.00)	(-0.69)	(14.09)	(-0.26)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2004 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

8. MELLÉKLET: COMMONALITY IN LIQUIDITY - SUBPERIOD 1 – CLOSING PERCENT

QUOTED SPREAD

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.212** (2.02)	-0.133 (-1.27)	-0.137 (-1.31)	-0.041 (-1.36)	0.001 (0.03)	0.016 (0.53)	-0.116 (-1.37)	-0.051 (-0.55)	-0.009 (-0.11)
WTI crude oil	0.077 (0.49)	-0.243 (-1.56)	0.254 (1.63)	-0.008 (-0.18)	0.039 (0.91)	-0.064 (-1.48)	-0.041 (-0.34)	-0.169 (-1.22)	-0.036 (-0.30)
Gasoil	-0.167* (-1.85)	-0.027 (-0.30)	0.098 (1.10)	0.026 (1.02)	-0.010 (-0.40)	-0.015 (-0.59)	0.086 (1.00)	0.108 (1.10)	0.161* (1.87)
Natural gas	-0.014 (-0.06)	-0.326 (-1.30)	0.173 (0.69)	0.004 (0.06)	0.037 (0.56)	-0.057 (-0.85)	-0.102 (-0.99)	-0.312*** (-2.82)	-0.290*** (-2.84)
Gasoline	0.076* (1.77)	-0.033 (-0.76)	0.028 (0.65)	-0.013 (-1.07)	0.007 (0.56)	-0.002 (-0.14)	0.163*** (2.62)	0.170** (2.42)	0.129** (2.08)
Heating oil	-0.082 (-0.55)	-0.383*** (-2.59)	-0.102 (-0.69)	0.009 (0.21)	0.044 (1.03)	0.021 (0.50)	-0.130 (-1.39)	0.012 (0.11)	-0.183** (-2.01)
Corn	0.028 (0.45)	0.012 (0.20)	0.025 (0.41)	0.020 (1.15)	0.048*** (2.77)	-0.054*** (-3.14)	0.060 (0.73)	-0.043 (-0.47)	0.059 (0.71)
Chicago wheat	-0.011 (-0.18)	0.010 (0.16)	0.130** (2.04)	-0.007 (-0.41)	0.005 (0.28)	-0.020 (-1.12)	-0.159** (-2.13)	-0.087 (-1.03)	0.002 (0.03)
Kansas wheat	-0.033 (-0.40)	-0.061 (-0.76)	0.068 (0.84)	0.019 (0.85)	0.046** (1.99)	-0.036 (-1.56)	0.167 (1.42)	0.212 (1.64)	0.245** (2.08)
Soybean	0.013 (0.26)	0.015 (0.31)	0.029 (0.58)	-0.001 (-0.09)	0.001 (0.09)	-0.061*** (-4.34)	0.026 (0.34)	0.082 (0.93)	0.141* (1.82)
Lean hogs	-0.005 (-0.03)	-0.050 (-0.30)	-0.037 (-0.22)	-0.018 (-0.39)	0.018 (0.38)	0.007 (0.14)	0.042 (0.16)	-0.143 (-0.50)	-0.439* (-1.72)
Live cattle	0.068 (0.96)	0.165** (2.34)	0.013 (0.18)	-0.009 (-0.48)	0.064*** (3.25)	-0.067*** (-3.41)	0.247 (1.51)	0.295 (1.62)	-0.141 (-0.88)
Feeder cattle	0.034 (0.78)	0.022 (0.52)	-0.008 (-0.20)	-0.002 (-0.17)	-0.007 (-0.54)	0.006 (0.50)	-0.106 (-0.79)	-0.438*** (-3.05)	-0.444*** (-3.40)
Gold	-0.458 (-1.08)	0.380 (0.90)	-0.032 (-0.08)	0.175 (0.33)	0.185 (0.34)	-0.048 (-0.09)	-0.122 (-0.20)	-0.434 (-0.64)	-0.209 (-0.35)
Silver	0.003 (0.05)	0.000 (-0.01)	-0.051 (-0.94)	0.003 (0.22)	0.000 (-0.03)	0.006 (0.38)	0.042 (0.51)	0.092 (1.01)	-0.029 (-0.35)
Copper	0.081 (0.90)	0.021 (0.24)	0.039 (0.43)	-0.016 (-0.64)	-0.009 (-0.37)	0.034 (1.33)	-0.167 (-1.04)	-0.131 (-0.72)	-0.180 (-1.11)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2000 - 31 December 2003 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

9. MELLÉKLET: COMMONALITY IN LIQUIDITY - SUBPERIOD 2 – CLOSING PERCENT

QUOTED SPREAD

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.030 (1.23)	0.080*** (3.22)	-0.008 (-0.33)	-0.031 (-1.50)	0.050** (2.41)	0.001 (0.05)	-0.009 (-0.42)	-0.011 (-0.47)	-0.019 (-0.84)
WTI crude oil	-0.040 (-1.45)	0.033 (1.19)	-0.047* (-1.70)	-0.014 (-0.57)	0.024 (0.99)	-0.012 (-0.51)	0.055** (2.50)	0.216*** (9.24)	0.161*** (7.33)
Gasoil	0.045* (1.91)	0.059** (2.45)	0.027 (1.15)	0.023 (1.14)	0.011 (0.54)	-0.081*** (-4.07)	-0.003 (-0.17)	0.003 (0.11)	0.000 (0.01)
Natural gas	-0.025 (-0.68)	0.108*** (2.86)	-0.100*** (-2.68)	-0.013 (-0.42)	-0.024 (-0.78)	0.020 (0.64)	0.012 (0.43)	-0.008 (-0.24)	0.030 (1.05)
Gasoline	-0.056** (-2.08)	-0.016 (-0.57)	-0.023 (-0.87)	-0.029 (-1.31)	0.072*** (3.27)	-0.024 (-1.07)	-0.027 (-0.87)	0.037 (1.08)	-0.047 (-1.50)
Heating oil	-0.093** (-2.05)	-0.071 (-1.55)	-0.004 (-0.09)	-0.126*** (-3.21)	0.073* (1.86)	0.004 (0.11)	-0.055 (-1.13)	0.079 (1.45)	0.055 (1.13)
Corn	0.106*** (2.81)	0.648*** (16.90)	0.111*** (2.95)	-0.015 (-0.50)	-0.069** (-2.29)	-0.061** (-2.03)	0.076* (1.95)	0.039 (0.91)	0.032 (0.83)
Chicago wheat	0.079 (1.18)	1.091*** (15.91)	0.166** (2.46)	-0.032 (-0.62)	-0.090* (-1.76)	0.030 (0.58)	-0.132** (-2.11)	-0.284*** (-4.08)	-0.150** (-2.39)
Kansas wheat	0.238*** (2.90)	1.079*** (12.84)	0.260*** (3.15)	0.078 (1.27)	-0.072 (-1.18)	0.024 (0.40)	-0.134* (-1.82)	-0.516*** (-6.34)	-0.354*** (-4.82)
Soybean	0.111** (2.41)	0.489*** (10.42)	0.073 (1.58)	0.010 (0.28)	-0.046 (-1.26)	-0.030 (-0.80)	0.113* (1.92)	-0.098 (-1.49)	0.015 (0.25)
Lean hogs	-0.003 (-0.10)	0.102*** (3.96)	-0.020 (-0.81)	0.003 (0.13)	-0.001 (-0.03)	-0.019 (-0.92)	0.026 (0.72)	0.204*** (5.03)	-0.017 (-0.46)
Live cattle	-0.035* (-1.71)	0.027 (1.29)	-0.055*** (-2.65)	0.001 (0.08)	0.003 (0.19)	0.027 (1.63)	0.046 (1.17)	0.302*** (6.82)	-0.054 (-1.37)
Feeder cattle	-0.013 (-0.37)	0.074** (2.02)	-0.024 (-0.67)	0.041 (1.43)	0.014 (0.50)	-0.002 (-0.08)	0.025 (0.35)	0.896*** (11.48)	0.121* (1.70)
Gold	-0.145* (-1.85)	-0.005 (-0.06)	-0.193** (-2.45)	-0.092 (-1.34)	-0.156** (-2.27)	-0.009 (-0.13)	0.267** (2.20)	-0.083 (-0.61)	-0.185 (-1.51)
Silver	-0.029 (-0.36)	0.657*** (8.15)	-0.087 (-1.09)	0.059 (0.96)	-0.066 (-1.07)	-0.166*** (-2.70)	-0.121* (-1.89)	-0.472*** (-6.65)	-0.334*** (-5.21)
Copper	-0.017 (-0.19)	0.553*** (6.36)	0.081 (0.94)	-0.092 (-1.38)	0.062 (0.93)	-0.029 (-0.44)	-0.239** (-2.54)	0.092 (0.88)	-0.167* (-1.77)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2004 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

10. MELLÉKLET: COMMONALITY IN LIQUIDITY - SUBPERIOD 1 – HIGH-LOW SPREAD

ESTIMATOR

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	0.147 (1.39)	0.998*** (8.64)	-0.016 (-0.16)	0.015 (1.19)	-0.014 (-1.09)	-0.010 (-0.73)	0.018 (0.42)	0.273*** (5.80)	0.128*** (3.00)
WTI crude oil	-0.179 (-1.48)	2.053*** (15.60)	-0.169 (-1.41)	0.017 (1.23)	-0.009 (-0.69)	-0.015 (-1.09)	-0.070 (-1.53)	0.160*** (3.09)	0.084* (1.84)
Gasoil	0.252*** (2.99)	0.704*** (7.59)	-0.029 (-0.35)	-0.005 (-0.43)	-0.001 (-0.10)	0.008 (0.79)	0.000 (0.00)	0.182*** (3.79)	0.053 (1.27)
Natural gas	-0.076 (-0.41)	1.586*** (7.75)	0.267 (1.44)	-0.024 (-1.10)	0.008 (0.36)	0.011 (0.50)	-0.021 (-0.54)	0.165*** (3.86)	0.173*** (4.38)
Gasoline	0.086* (1.82)	0.020 (0.39)	0.039 (0.84)	0.024*** (3.80)	-0.002 (-0.27)	-0.001 (-0.11)	0.023 (0.62)	0.241*** (5.84)	0.194*** (5.31)
Heating oil	-0.173 (-1.38)	1.743*** (12.73)	-0.001 (-0.01)	-0.026* (-1.79)	0.036** (2.38)	0.012 (0.83)	0.039 (1.03)	0.172*** (3.95)	0.092** (2.48)
Corn	0.006 (0.10)	0.435*** (6.35)	0.013 (0.21)	0.014* (1.70)	-0.003 (-0.41)	-0.002 (-0.28)	0.049 (1.10)	0.221*** (4.43)	0.096** (2.16)
Chicago wheat	-0.005 (-0.05)	0.760*** (8.18)	0.068 (0.82)	-0.001 (-0.12)	0.002 (0.23)	-0.006 (-0.61)	0.043 (0.85)	0.294*** (5.23)	0.294*** (5.86)
Kansas wheat	0.046 (0.78)	0.545*** (8.33)	-0.013 (-0.22)	-0.003 (-0.41)	0.001 (0.16)	0.001 (0.16)	0.032 (0.71)	0.244*** (4.92)	0.156*** (3.45)
Soybean	-0.041 (-0.68)	0.514*** (7.67)	0.060 (0.99)	0.007 (0.84)	0.000 (-0.05)	0.001 (0.15)	0.027 (0.55)	0.301*** (5.32)	0.156*** (3.16)
Lean hogs	0.054 (0.80)	0.508*** (6.87)	-0.038 (-0.56)	-0.003 (-0.31)	-0.007 (-0.77)	0.010 (1.20)	0.077 (1.38)	0.296*** (4.72)	0.141** (2.51)
Live cattle	0.052 (1.35)	0.261*** (6.20)	0.023 (0.61)	0.002 (0.45)	0.001 (0.20)	-0.003 (-0.63)	-0.086* (-1.81)	0.264*** (4.98)	0.194*** (4.16)
Feeder cattle	-0.005 (-0.20)	0.105*** (3.74)	0.040 (1.61)	-0.001 (-0.23)	-0.001 (-0.27)	-0.002 (-0.49)	-0.055 (-1.29)	0.267*** (5.87)	0.229*** (5.55)
Gold	0.064 (1.61)	0.336*** (7.74)	0.044 (1.11)	0.007 (0.23)	0.036 (1.13)	-0.068** (-2.23)	0.044 (1.28)	0.241*** (6.23)	0.068** (1.97)
Silver	-0.023 (-0.40)	0.456*** (7.38)	0.026 (0.47)	-0.006 (-0.78)	0.002 (0.27)	0.000 (0.04)	0.040 (0.92)	0.410*** (8.38)	0.245*** (5.60)
Copper	0.102* (1.89)	0.464*** (7.84)	0.052 (0.98)	-0.001 (-0.12)	0.004 (0.56)	-0.002 (-0.29)	0.096* (1.88)	0.187*** (3.23)	0.070 (1.36)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2000 - 31 December 2003 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.

11. MELLÉKLET: COMMONALITY IN LIQUIDITY - SUBPERIOD 2 – HIGH-LOW SPREAD

ESTIMATOR

	$\Delta L_{M,i,t-1}$	$\Delta L_{M,i,t}$	$\Delta L_{M,i,t+1}$	$R_{M,i,t-1}$	$R_{M,i,t}$	$R_{M,i,t}$	$\Delta V_{i,t-1}$	$\Delta V_{i,t}$	$\Delta V_{i,t+1}$
Brent oil	1.241 (0.49)	0.046*** (24.69)	0.024 (1.04)	-0.047 (1.21)	0.046** (-2.36)	0.074** (2.32)	0.199*** (3.50)	0.131*** (8.50)	0.215*** (6.17)
WTI crude oil	1.806 (0.40)	-0.073*** (29.52)	0.019 (-1.36)	-0.010 (0.80)	0.063 (-0.41)	-0.061*** (2.64)	0.296*** (-2.76)	0.176*** (12.62)	0.306*** (7.95)
Gasoil	0.825** (2.46)	-0.037*** (18.83)	0.020 (-0.96)	-0.051 (1.14)	0.047*** (-2.89)	0.003*** (2.64)	0.188 (0.18)	0.146*** (9.26)	0.150*** (8.10)
Natural gas	1.011 (-0.15)	-0.086*** (13.33)	-0.019 (-1.28)	0.079 (-0.65)	-0.067*** (2.64)	0.041** (-2.24)	0.224 (1.51)	0.249*** (7.30)	0.091*** (9.10)
Gasoline	0.037*** (5.47)	0.018 (1.40)	-0.011 (0.75)	0.011 (-1.01)	0.004 (1.02)	0.008 (0.35)	0.164 (0.50)	0.169*** (9.45)	0.041*** (10.60)
Heating oil	1.607* (-1.93)	0.029*** (34.92)	0.000 (0.73)	0.019 (0.02)	0.012 (1.01)	-0.016 (0.64)	0.112 (-0.71)	0.118*** (4.33)	0.346*** (5.10)
Corn	0.559** (-2.55)	-0.024*** (14.07)	-0.009 (-0.67)	-0.013 (-0.53)	-0.006 (-0.81)	-0.011 (-0.35)	0.162 (-0.50)	0.091*** (6.86)	0.101*** (4.29)
Chicago wheat	0.773 (-0.89)	-0.105*** (17.37)	-0.024*** (-2.68)	0.015 (-1.33)	0.014 (0.80)	0.023 (0.79)	0.188 (1.05)	0.100*** (7.61)	0.138*** (4.49)
Kansas wheat	0.753 (-1.59)	-0.093*** (18.98)	0.003*** (-2.67)	-0.003 (0.17)	0.018 (-0.16)	0.021 (1.14)	0.213 (1.05)	0.130*** (9.82)	0.167*** (6.60)
Soybean	0.532*** (-2.69)	-0.051*** (16.64)	-0.008* (-1.82)	0.004 (-0.60)	0.024 (0.31)	0.019* (1.81)	0.197 (0.92)	0.108*** (8.33)	0.136*** (5.12)
Lean hogs	0.348 (1.13)	0.015*** (11.70)	-0.006 (0.57)	0.006 (-0.50)	0.009 (0.46)	0.005 (0.73)	0.247 (0.24)	0.142*** (10.34)	0.072*** (6.62)
Live cattle	0.319 (-1.10)	-0.030*** (15.30)	0.001* (-1.66)	-0.005 (0.11)	0.008 (-0.62)	0.021 (0.92)	0.286 (1.04)	0.250*** (12.70)	0.148*** (12.47)
Feeder cattle	0.219 (-0.86)	-0.028*** (11.30)	0.008 (-1.62)	-0.011 (1.07)	0.006 (-1.43)	0.036 (0.73)	0.249* (1.83)	0.143*** (11.53)	0.088*** (7.25)
Gold	0.354 (-0.22)	0.009*** (15.86)	-0.014 (0.45)	0.058 (-1.37)	-0.035*** (5.68)	0.030*** (-3.44)	0.194* (1.67)	0.085*** (9.61)	0.114*** (4.65)
Silver	0.581 (-0.92)	-0.002*** (14.41)	-0.008 (-0.07)	0.022 (-0.46)	-0.023 (1.31)	0.008 (-1.36)	0.135 (0.49)	0.037*** (6.96)	0.095** (2.11)
Copper	0.573 (-1.30)	0.069*** (14.91)	-0.014** (2.04)	0.006 (-0.86)	-0.027 (0.37)	-0.015* (-1.73)	0.212 (-0.66)	0.050*** (8.41)	0.103** (2.20)

We report the coefficients from the market model regression for 16 commodities. We use data for the 1 January 2004 - 31 December 2021 period. Daily changes in individual liquidity are regressed on changes in market-wide liquidity and control variables (market return, change in individual volatility). The coefficients in each column belong to the ‘Lag’, ‘Concurrent’ and ‘Lead’ variables. The values in parentheses denote t-stats from the regression. *, **, *** denote significance at 10%, 5% and 1% level respectively.