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Commonality in Liquidity: A Global Perspective

Paul Brockman, Dennis Y. Chung, and Christophe Pérignon*

Abstract

We conduct a comprehensive study of commonality in liquidity using intraday spread and depth data from 47 stock exchanges. We find that firm-level changes in liquidity are significantly influenced by exchange-level changes across most of the world's stock exchanges. Emerging Asian exchanges have exceptionally strong commonality, while those of Latin America exhibit little if any commonality. After documenting the pervasive role of commonality *within* individual exchanges, we examine commonality *across* exchanges. We find evidence of a distinct, global component in bid-ask spreads and depths. Local (exchange-level) sources of commonality represent roughly 39% of the firm's total commonality in liquidity, while global sources contribute an additional 19%. We also investigate potential sources of exchange-level and global commonality. We show that commonality is driven by both domestic and U.S. macroeconomic announcements.

I. Introduction

Commonality in liquidity refers to the impact of a common or marketwide liquidity factor on an individual firm, both in terms of bid-ask spreads and depths. Previous empirical research has shown that there exists a significant common component that influences firm-level liquidity. Simply stated, liquidity is subject to a spillover effect that influences other firms trading in the same market. Although there is some evidence of commonality on non-U.S. exchanges (Brockman and Chung (2002), Fabre and Frino (2004)), most previous studies investigate firms trading in U.S. markets (Chordia, Roll, and Subrahmanyam (2000), Hasbrouck and Seppi (2001), and Huberman and Halka (2001)). Regardless of the particular market investigated, all previous studies using intraday

*Brockman, pab309@lehigh.edu, College of Business and Economics, Lehigh University, 621 Taylor St., Bethlehem, PA 18015; Chung, dychung@sfu.ca, Faculty of Business Administration, Simon Fraser University, 8888 University Dr., Burnaby, BC Canada V5A 1S6; Pérignon, perignon@hec.fr, Department of Finance and Economics, HEC Paris, 1, Rue de la Libération, 78351 Jouy-en-Josas, France. We thank Hendrik Bessembinder (the editor), Thierry Foucault, Albert Menkveld, Asani Sarkar, Olivier Scaillet, Daniel Smith, Avanidhar Subrahmanyam, an anonymous referee, participants at the 2006 Northern Finance Association Conference and at the 2006 Bank of Canada Workshop on Microstructure of Foreign Exchange and Equity Markets, and seminar participants at HEC Montreal, HEC Paris, Imperial College London, Simon Fraser University, and University of Geneva for useful comments and suggestions. Chung thanks the Simon Fraser University President's Research Grant for partial financial support. This paper was accepted while Brockman was at the University of Missouri-Columbia.

bid-ask spreads and depths are single-exchange studies. The purpose of our paper is threefold. First, we conduct a comprehensive investigation of commonality in liquidity for 47 stock exchanges using intraday spread and depth data. Second, and perhaps most importantly, we investigate the extent to which commonality is a global versus local (i.e., exchange-level) phenomenon. Third, we investigate the sources of commonality both within and across exchanges.

Most of the early liquidity studies analyze firm-specific determinants of liquidity. This line of research has shown that variations in price, volume, and volatility explain much of the cross-sectional variation in bid-ask spreads (Benston and Hagerman (1974), Stoll (1978), and Barclay and Smith (1988)) and depths (Brockman and Chung (1999)). It has also shown that a firm's liquidity level significantly affects its cost of capital (Amihud (2002)). More recent research focuses on the common components of firm liquidity (i.e., changes in firm-level bid-ask spreads and depths caused by changes in market-level spreads and depths). This line of research has shown that individual firm liquidity is sensitive to changes in aggregate liquidity (Chordia et al. (2000), Coughenour and Saad (2004), and Chordia, Sarkar, and Subrahmanyam (2005)). One implication of these findings is that sensitivity to aggregate liquidity movements might represent a systematic risk factor (Eckbo and Norli (2002), Pastor and Stambaugh (2003), Acharya and Pedersen (2005), Sadka (2006), Bekaert, Harvey, and Lundblad (2007), and Korajczyk and Sadka (2008)).

Over the past three decades, capital markets have become increasingly globalized because of lower information technology costs and a movement toward deregulation and free trade on the part of national governments. Concomitant with globalized capital movements are globalized liquidity movements. Commenting on these global movements, Peter Weinberg (2006), former chief executive officer of Goldman Sachs International, states that "liquidity and the movement of capital around the world have become so ubiquitous and pervasive that it is hard to know where London or New York begins and where Tokyo, Shanghai or Hong Kong leaves off." A primary objective of our study is to examine the relation between liquidity changes in London or New York, for instance, and liquidity movements in Tokyo, Shanghai, Hong Kong, and the rest of the world.

To date, our knowledge of spread and depth comovements is limited to empirical evidence from only a handful of individual stock exchanges (e.g., U.S., Hong Kong, and Australia).[1] This limitation means that many important questions remain unanswered. Is commonality in spreads and depths widespread across the world's stock exchanges? Is commonality a more serious problem for emerging or developed markets? Does firm size or industry play a significant role in transmitting liquidity shocks across firms? Is there a global component to commonality in liquidity—or is it merely a local phenomenon? What are the sources of commonality? We address these and related questions by accessing a global

[1]Stahel (2003) uses monthly returns and turnover to investigate comovement among the U.S., Japanese, and U.K. stock markets. Stahel (2005) uses a weekly illiquidity measure to examine liquidity across 18 developed and emerging markets. More recently, Karolyi, Lee, and van Dijk (2008) use a large database of over 20,000 stocks across 40 countries to obtain monthly measures of commonality in returns, liquidity, and turnover. No previous study, however, analyzes global commonality in bid-ask spreads or depths.

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Bloomberg database that encompasses 1.47 billion transactions across 47 stock exchanges, 38 countries, and the six major geographic regions defined by Morgan Stanley Capital International (MSCI).

We divide our empirical investigation into three sections. In the first section, we use the methodology of Chordia et al. (2000) to measure commonality in spreads and depths for each of our 47 stock exchanges. Our results verify that exchange-level commonality is a pervasive phenomenon across the globe. On most exchanges, but not all, individual firms' spreads and depths are significantly influenced by changes in the aggregate market's spreads and depths. Although most exchanges have a significant commonality component, there are also large cross-sectional variations among exchanges and geographic regions. The stock exchanges of emerging Asia, for example, exhibit the strongest commonality in spreads, while the exchanges of North America have the strongest commonality in depths. Latin American stock exchanges exhibit very little commonality at the exchange level. In addition, we investigate the roles of firm size and industry within each of our exchanges. Overall, our evidence shows definitively that commonality in liquidity is widespread *within* individual stock exchanges.

In the second section of our analysis, we examine commonality in liquidity *across* stock exchanges. Is exchange-level liquidity influenced by regional or global liquidity movements? Does the sensitivity of exchange-level liquidity to global commonality depend on the size of the exchange? To what extent is firm-level commonality caused by local versus global factors? To answer these and related questions, we extend the empirical model of Chordia et al. (2000) to measure the impact of changes in global liquidity on changes in aggregate exchange-level liquidity. We also extend this model to determine the extent to which firm liquidity is explained by local versus global sources of commonality. To the best of our knowledge, no previous study has examined global sources of commonality in spreads and depths.

Our empirical tests generate several new findings. We find unambiguous support for the hypothesis that commonality in liquidity spills across national borders. Movements in aggregate bid-ask spreads and depths on an individual exchange are significantly influenced by movements in spreads and depths at the global scale. We show that both developed and emerging markets are susceptible to global commonality, although developed markets are more sensitive to liquidity spillover effects than are emerging markets. We also show that global commonality is not driven solely by regional comovements. These results have potential implications for the pricing of liquidity risk in an international setting (Lee (2006)).

Next, we analyze the local (i.e., own exchange) versus global sources of commonality in liquidity after orthogonalizing all independent variables.[2] We find that local (exchange-level) sources contribute 38.32% of the typical firm's bid-ask spread commonality, while global sources contribute 19.09%. Similarly, we find that local sources contribute 39.87% of the typical firm's depth-related commonality, while global sources contribute 18.76%. These findings suggest that the local source of commonality plays the dominant role for both spreads and depths.

[2]We thank an anonymous referee for suggesting this line of inquiry.

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However, after accounting for local, industry, and regional sources of commonality, we show that the global component contributes 10% to 15% of the typical firm's commonality in liquidity.

In the third section of our analysis, we investigate potential sources of commonality both within and across exchanges. We examine the impact of domestic macroeconomic announcements on commonality in liquidity for each of our 47 exchanges. We identify 6,046 macroeconomic announcements related to interest rates, consumer prices, unemployment figures, and gross domestic product (GDP) releases from a total of 23,445 macroeconomic news items. During the resulting 2,847 (exchange-level) macro news days, we find a significant increase in commonality for both spreads and depths. We also investigate the impact of U.S. macroeconomic announcements on global commonality. Although weaker than domestic economy announcements, U.S. macroeconomic announcements significantly increase commonality levels across global markets. These announcement effects are stronger for emerging markets as a group than for developed markets.

In summary, our empirical results verify that neither firm- nor exchange-level liquidity can be understood in isolation. Individual firm liquidity is significantly influenced by comovements in the liquidity of all other firms traded on the same exchange. This result is widespread across most exchanges in the world. In a parallel manner, exchange-level liquidity is significantly influenced by comovements in the global liquidity of other exchanges. Individual firms are subject to local, industry, regional, and global sources of commonality. Our investigation into the determinants of commonality shows that commonality responds to changes in the domestic and global macroeconomic environment.

In Section II, we discuss our data and provide some descriptive statistics. In Section III, we present and interpret our empirical findings. In Section IV, we summarize and conclude our study.

II. Data and Descriptive Statistics

A. Data

We obtain trade and quote data from the Bloomberg financial information network. Bloomberg receives real-time bid and ask quotes and transaction data for stocks traded on global markets through a live feed directly from the exchanges. Intraday data on the U.S. exchanges, not available from Bloomberg due to data licensing restrictions, are obtained from the New York Stock Exchange (NYSE) Trade and Quote (TAQ) database. We compile intraday bid-ask spread and depth measures over a 21-month period from October 1, 2002, to June 30, 2004 (455 trading days). We require a minimum of 200 days with at least one trade during the sample period in order to eliminate inactively traded firms. Firms with market capitalization of less than $100 million and exchanges with less than 10 sample firms are also excluded from our analysis. Our final sample contains 1.47 billion transactions across 47 stock exchanges, 38 countries, and the six major regions as defined by MSCI.[3] After calculating daily averages, we have 3,838,241 daily

[3]These 1.47 billion transactions are extracted from roughly 15 billion quote and trade observations over our 21-month sample period.

observations representing the number of firm-days with trades for all of our 9,427 firms.

B. Descriptive Statistics

We present descriptive statistics for our global database in Table 1. We report the exchange, country, MSCI region, number of firms, total market capitalization, average dollar trading volume, average number of trades, percentage of days with trades, average relative effective spreads, and average dollar value depths.[4] All averages are calculated on a per firm, per day basis. The developed market group includes 16 European exchanges, four North American exchanges, and seven Pacific exchanges; the emerging market group includes 11 Asian exchanges, four European, Middle Eastern, and African exchanges, and five Latin American exchanges.

Our descriptive statistics reveal considerable cross-sectional variation both within the six regions and (especially) across these regions. The number of actively traded firms varies from a low of 13 for the Budapest and Lima Stock Exchanges to a high of 1,515 for NASDAQ; total market capitalization ranges from $6.8 billion for Korea's KOSDAQ to $9,092.1 billion for the NYSE; average trading volume ranges from $5.6 thousand on the Istanbul Stock Exchange to $50,596.3 thousand on Switzerland's Virt-X; and the average number of daily trades varies from four on the Johannesburg Stock Exchange to 1,697 on KOSDAQ. Most exchanges have a large percentage of days with active trades.

In the last two columns of Table 1, we report average relative effective spreads and average dollar depths. We define relative effective spreads as twice the absolute value of the transaction price deviation from the bid-ask midpoint, divided by the bid-ask midpoint. We define dollar depths (or depth in value) as the number of shares at the bid and ask prices multiplied by their corresponding prices (in U.S. dollar terms).[5] Over half of the exchanges in our sample have relative spreads that are less than 1% of the bid-ask midpoint. Only three stock exchanges (Jakarta, Sao Paulo, and Lima) have relative spreads that exceed 2%. Of the nine exchanges with relative spreads of less than 0.5%, seven are located in Asia (Shanghai, Shenzhen, Bombay, National Stock Exchange of India, Tokyo, KOSDAQ, and the Korea Exchange), one in Europe (Virt-X), and one in North America (NYSE). Our dollar depth figures vary from a low of $523 for the Istanbul Stock Exchange to $827,649 for the electronic Virt-X.[6]

[4]We convert local currency amounts into U.S. dollars using the daily historical spot exchange rates obtained from Bloomberg. In a subsequent analysis, we rerun the results in Tables 2 and 3 without converting to U.S. dollars. Although there are some differences in the magnitudes of coefficient estimates, the signs and significance levels of the coefficient estimates are highly consistent.

[5]In addition to relative effective bid-ask spreads, we also test for commonality in liquidity using i) effective spreads, ii) quoted spreads, and iii) relative quoted spreads. In addition to dollar depths, we also test for commonality using share depths. Our conclusions are unchanged by these alternative definitions of liquidity.

[6]Our Bloomberg database does not include depth figures for two exchanges: the New Zealand Exchange and the London Stock Exchange.

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TABLE 1

Descriptive Statistics

Table 1 presents, for each sample exchange, the name, country, region (MSCI), number of listed firms, total market capitalization in billions of US$, and several descriptive statistics computed over the period from October 1, 2002 to June 30, 2004. The MSCI regions are Europe (Developed Markets—Europe), N-America (Developed Markets—North America), Pacific (Developed Markets—Pacific), Asia (Emerging Markets—Asia), Europe-MEA (Emerging Markets—Europe, Middle East, and Africa), and Latin America (Emerging Markets—Latin America). Trading Volume (thousand US$) is the average value of shares traded per day and per firm measured in thousands of US$, No. of Trades is the average number of transactions per day and per firm, % of Days with Trades is the percentage of trading days with at least one transaction, Relative Effective Spread is the effective spread (i.e., twice the absolute trading price deviation from the bid-ask midpoint) divided by the bid-ask midpoint, and Total Depth in Value is the number of shares at the bid and ask multiplied by their respective prices converted into US$. Each trading activity and liquidity measure is averaged across day for each firm, and then their mean is computed across firms.

#	Exchange	Country	Region	No. of Firms	Total Market Cap. (billions US$)	Trading Volume (thousands US$)	No. of Trades	% of Days with Trades	Relative Effective Spread	Total Depth in Value (US$)
1	Vienna Stock Exchange	Austria	Europe	27	25.3	1,100.1	26	94%	0.0088	120,603
2	Copenhagen Stock Ex.	Denmark	Europe	60	81.7	2,942.5	91	95%	0.0093	145,705
3	Helsinki Stock Exchange	Finland	Europe	62	152.1	7,487.1	163	94%	0.0105	146,615
4	Euronext Paris	France	Europe	221	913.0	12,388.5	502	69%	0.0092	191,320
5	Deutsche Boerse	Germany	Europe	134	579.8	25,033.9	369	98%	0.0082	61,895
6	Frankfurt Stock Exchange	Germany	Europe	41	63.1	317.5	20	82%	0.0170	35,308
7	Athens Stock Exchange	Greece	Europe	90	52.6	772.4	177	99%	0.0080	130,324
8	Irish Stock Exchange	Ireland	Europe	25	56.7	5,617.8	36	95%	0.0122	136,911
9	Borsa Italiana	Italy	Europe	121	408.6	13,786.8	611	98%	0.0075	40,307
10	Oslo Stock Exchange	Norway	Europe	52	47.9	4,018.2	113	92%	0.0127	140,424
11	Euronext Lisbon	Portugal	Europe	28	44.5	2,988.2	158	95%	0.0093	299,436
12	Spanish Continuous Market	Spain	Europe	86	360.2	18,071.4	430	98%	0.0058	465,967
13	Stockholm Stock Exchange	Sweden	Europe	117	264.3	8,636.2	237	97%	0.0090	476,574
14	Swiss Exchange	Switzerland	Europe	106	137.0	727.1	42	91%	0.0111	89,735
15	Virt-X	Switzerland	Europe	26	472.4	50,596.3	1,121	100%	0.0021	827,649
16	London Stock Exchange	UK	Europe	550	1,852.6	5,315.3	57	96%	0.0139	N/A
17	Toronto Stock Exchange	Canada	N-America	314	567.8	3,990.7	240	97%	0.0085	585
18	American Stock Exchange	USA	N-America	55	40.6	2,198.0	169	98%	0.0115	52,798
19	NASDAQ	USA	N-America	1,515	2,137.7	6,938.5	688	99%	0.0060	21,243
20	New York Stock Exchange	USA	N-America	1,475	9,092.1	20,690.6	729	100%	0.0041	57,880
21	Australian Stock Exchange	Australia	Pacific	199	406.5	4,276.4	177	98%	0.0066	153,750
22	Hong Kong Exchange	Hong Kong	Pacific	225	566.7	8,689.9	151	96%	0.0108	606,525
23	JASDAQ	Japan	Pacific	59	14.9	921.3	69	93%	0.0111	43,288
24	Osaka Securities Exchange	Japan	Pacific	70	80.1	2,568.4	121	90%	0.0068	58,794
25	Tokyo Stock Exchange	Japan	Pacific	1,201	1,873.8	4,754.5	164	91%	0.0049	146,937
26	New Zealand Exchange	New Zeal.	Pacific	33	65.5	869.5	32	98%	0.0076	N/A
27	Singapore Exchange Ltd	Singapore	Pacific	105	151.6	2,061.0	86	98%	0.0104	381,579
28	Shanghai Stock Exchange	China	Asia	598	271.3	779.6	183	98%	0.0025	13,202
29	Shenzhen Stock Exchange	China	Asia	527	191.3	755.1	204	98%	0.0026	12,682
30	Bombay Stock Exchange	India	Asia	119	104.8	701.1	505	98%	0.0035	2,695
31	National Stock Ex. of India	India	Asia	111	102.2	1,512.1	501	98%	0.0025	3,425
32	Jakarta Stock Exchange	Indonesia	Asia	32	25.4	1,199.5	137	96%	0.0295	469,623
33	KOSDAQ Market Division	Korea	Asia	16	6.8	6,489.1	1,697	100%	0.0040	54,332
34	Korea Exchange	Korea	Asia	140	176.2	6,430.0	1,037	99%	0.0039	111,408
35	Bursa Malaysia	Malaysia	Asia	160	106.4	606.5	60	97%	0.0094	92,281
36	Philippine Stock Exchange	Philippines	Asia	27	30.4	290.3	44	93%	0.0183	70,642
37	Taiwan Stock Exchange	Taiwan	Asia	289	212.4	5,763.2	221	99%	0.0053	294,005
38	Stock Ex. of Thailand	Thailand	Asia	80	49.5	2,202.8	203	96%	0.0094	193,232
39	Budapest Stock Exchange	Hungary	Europe-MEA	13	12.0	1,745.2	127	96%	0.0124	27,841
40	Warsaw Stock Exchange	Poland	Europe-MEA	26	22.9	987.1	156	96%	0.0084	49,190
41	Johannesburg Stock Ex.	S. Africa	Europe-MEA	74	145.9	717.2	4	82%	0.0100	149,975
42	Istanbul Stock Exchange	Turkey	Europe-MEA	59	39.2	5.6	883	100%	0.0098	523
43	Buenos Aires Stock Ex.	Argentina	Latin America	19	87.4	456.6	103	97%	0.0116	23,169
44	Sao Paulo Stock Exchange	Brazil	Latin America	45	90.1	649.9	66	86%	0.0238	31,987
45	Santiago Stock Exchange	Chile	Latin America	43	42.4	508.2	19	85%	0.0180	25,770
46	Mexican Stock Exchange	Mexico	Latin America	39	146.4	2,318.3	84	93%	0.0124	118,985
47	Lima Stock Exchange	Peru	Latin America	13	10.0	103.0	10	86%	0.0276	235,586
	All exchanges combined	All	All	9,427	22,382.4	7,593.6	378	96%	0.0067	105,646

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III. Empirical Results

We divide our empirical findings into three main sections: The first section investigates the pervasiveness of comovements in liquidity by estimating Chordia et al.'s (2000) commonality measures for each of our 47 exchanges. The second section examines commonality in liquidity at the global scale. The third section investigates potential determinants of commonality.

A. Exchange-Level Commonality

In the first section of our analysis, we apply the methodology of Chordia et al. (2000) to our 47 stock exchanges. For each exchange, we test for commonality in liquidity using the following firm-by-firm time-series regression:

$$\begin{aligned}(1)\qquad \Delta\text{LIQUIDITY}_{F,t} &= \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} \\ &\quad + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1} \\ &\quad + \delta_3 \text{RETURN}_{E,t-1} + \delta_4 \Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t},\end{aligned}$$

where $\text{LIQUIDITY}_{F,t}$ is measured by either $\text{SPREAD}_{F,t}$ or $\text{DEPTH}_{F,t}$. Here, $\text{SPREAD}_{F,t}$ is the average of intraday relative effective bid-ask spreads for firm F on day t. Similarly, $\text{DEPTH}_{F,t}$ is the average of intraday dollar depths for firm F on day t. $\text{VOLATILITY}_{F,t}$ is the return volatility for firm F on trading day t and is measured as the average squared return. $\text{LIQUIDITY}_{E,t}$ is an equal-weighted average of each corresponding liquidity measure for all firms trading on the same stock market.[7] $\text{RETURN}_{E,t}$ is the equal-weighted average of the daily return for all firms trading on the same stock market. All dependent and independent variables are expressed in terms of proportional changes (denoted as Δ) in the variable across successive trading days. All exchange averages exclude the dependent-variable firm; that is, $\text{LIQUIDITY}_{E,t}$ and $\text{RETURN}_{E,t}$ are calculated using all firms on the exchange except firm F.

One of our primary variables of interest is the contemporaneous coefficient on $\Delta\text{LIQUIDITY}_{E,t}$ (i.e., β_1). A positive and significant β_1 would mean that exchange-level liquidity changes exert a substantial influence on firm F's liquidity. Another important variable is the adjusted R^2 value (both averages and medians) of the overall regression. While the relative magnitudes of the adjusted R^2s will generally agree with the relative magnitudes of the contemporaneous coefficients, the adjusted R^2s account for both systematic and idiosyncratic variation and are less subject to scaling effects.[8]

In Table 2, we report the following relative effective bid-ask spread results for each of our 47 stock exchanges: average and median contemporaneous liquidity coefficients from regression model (1); the percentage of firms with positive

[7] It is possible to use an equal-weighted average or a value-weighted average in constructing the market average. Although we report the equal-weighted results in subsequent sections, rerunning our analysis using value-weighted averages does not alter our conclusions.

[8] The contemporaneous coefficients, or betas, are more susceptible to scaling effects across exchanges because aggregate liquidity volatility (i.e., the beta denominator) differs across exchanges. We thank an anonymous referee for pointing out the benefits of analyzing adjusted R^2s.

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and significant coefficients, positive and insignificant coefficients, negative and insignificant coefficients, and negative and significant coefficients; median sum of lead, lag, and contemporaneous coefficients; and average (median) adjusted R^2 values. Unless otherwise stated, we use a significance level of 5% to differentiate significant from insignificant results.

Our findings in Table 2 provide strong support for the postulation that changes in an individual firm's bid-ask spreads are significantly influenced by a common (exchange-wide) liquidity factor. These results confirm that commonality in

TABLE 2

Exchange-Level Commonality: Spread Results

Firm-by-firm (9,427) time-series regressions of liquidity measures are estimated using regression (1):

$$(1)\quad \Delta\text{LIQUIDITY}_{F,t} = \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1} + \delta_3 \text{RETURN}_{E,t-1} + \delta_4 \Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t}.$$

$\text{LIQUIDITY}_{F,t}$ is the relative effective spread of firm F on day t. $\text{LIQUIDITY}_{E,t}$ is the exchange-level liquidity index, and $\text{RETURN}_{E,t}$ is the exchange-level return computed on day t using an equal-weighted average of the liquidity measure and return, respectively, for all firms trading on the same exchange, except firm F. $\text{VOLATILITY}_{F,t}$ is the return volatility for firm F on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. We present the average and median coefficient estimate of the exchange-level liquidity beta β_1, along with the percent of firms for which β_1 is positive and significant at the 5% confidence level (t-statistic > 1.645), positive and not significant at the 5% confidence level, negative and not significant at the 5% confidence level, and negative and significant at the 5% confidence level, respectively. We report in the last three columns the median of the sum of the contemporaneous, lead, and lag coefficient estimates ($\text{SUM}_E = \beta_1 + \beta_2 + \beta_3$), and the average- and median-adjusted R^2s. Here, *, **, and *** indicate that the hypothesis median (SUM_E) = 0 is rejected by a sign test at the 10%, 5%, and 1% confidence levels, respectively.

#	Exchange	Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM_E Coeff.	Avg. Adj. R^2	Median Adj. R^2
	Europe									
1	Vienna Stock Exchange	0.2041	0.2464	29.63%	40.74%	22.22%	7.41%	0.1361	0.015	0.009
2	Copenhagen Stock Ex.	0.1958	0.1918	16.67%	58.33%	25.00%	0.00%	0.2456***	0.020	0.016
3	Helsinki Stock Exchange	0.1673	0.0885	12.90%	58.06%	27.42%	1.61%	0.0344	0.019	0.011
4	Euronext Paris	0.2115	0.1347	7.73%	60.00%	31.36%	0.91%	0.1663***	0.019	0.012
5	Deutsche Boerse	0.2065	0.2484	25.56%	53.38%	21.05%	0.00%	0.3845***	0.015	0.010
6	Frankfurt Stock Exchange	0.2871	0.0696	5.13%	48.72%	43.59%	2.56%	0.0084	–0.003	–0.006
7	Athens Stock Exchange	0.2054	0.2099	23.33%	64.44%	11.11%	1.11%	0.1166***	0.028	0.017
8	Irish Stock Exchange	0.2409	0.2274	52.00%	36.00%	12.00%	0.00%	0.2886***	0.012	0.011
9	Borsa Italiana	0.0614	0.0198	5.79%	57.02%	36.36%	0.83%	0.0318***	0.037	0.012
10	Oslo Stock Exchange	0.1075	0.0372	13.46%	42.31%	42.31%	1.92%	0.0098	0.018	0.013
11	Euronext Lisbon	0.2687	0.1596	25.00%	60.71%	14.29%	0.00%	0.1381***	0.023	0.016
12	Spanish Cont. Market	0.1337	0.1845	30.59%	54.12%	15.29%	0.00%	0.1821***	0.022	0.009
13	Stockholm Stock Exchange	0.0644	0.0391	10.26%	54.70%	31.62%	3.42%	0.0544**	0.031	0.013
14	Swiss Exchange	0.1817	0.2195	8.49%	65.09%	25.47%	0.94%	0.2602***	0.011	0.007
15	Virt-X	0.3384	0.3283	80.77%	15.38%	3.85%	0.00%	0.4916***	0.064	0.056
16	London Stock Exchange	1.2183	1.1251	42.07%	47.42%	9.96%	0.55%	1.2318***	0.012	0.009
	North America									
17	Toronto Stock Exchange	0.7902	0.6675	57.56%	35.69%	6.75%	0.00%	0.7724***	0.032	0.019
18	American Stock Exchange	0.2900	0.0665	22.64%	50.94%	26.42%	0.00%	0.0295	0.049	0.002
19	NASDAQ	0.9248	0.6995	72.98%	24.30%	2.72%	0.00%	0.6661***	0.037	0.031
20	New York Stock Exchange	0.3550	0.2022	20.73%	55.46%	22.86%	0.96%	0.1796***	0.024	0.012
	Pacific									
21	Australian Stock Exchange	0.5880	0.3581	58.08%	33.84%	8.08%	0.00%	0.2629***	0.043	0.025
22	Hong Kong Exchange	0.1662	0.0703	8.89%	59.56%	28.44%	3.11%	0.0594**	0.027	0.015
23	JASDAQ	0.1229	0.0515	1.69%	59.32%	37.29%	1.69%	0.0612	0.013	0.009
24	Osaka Securities Exchange	0.2336	0.1677	17.14%	61.43%	17.14%	4.29%	0.1588***	0.019	0.013
25	Tokyo Stock Exchange	0.8011	0.5388	64.15%	29.15%	6.62%	0.08%	0.5187***	0.056	0.039
26	New Zealand Exchange	0.1671	0.1139	12.12%	57.58%	30.30%	0.00%	0.1089	0.018	0.010
27	Singapore Exchange Ltd	0.1341	0.0813	15.24%	56.19%	23.81%	4.76%	0.1140***	0.026	0.014

(continued on next page)

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TABLE 2 (continued)

Exchange-Level Commonality: Spread Results

#	Exchange	Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM_E Coeff.	Avg. Adj. R^2	Median Adj. R^2
	Emerging—Asia									
28	Shanghai Stock Exchange	0.7586	0.7273	82.61%	14.38%	3.01%	0.00%	0.6746***	0.074	0.072
29	Shenzhen Stock Exchange	0.7472	0.6996	86.91%	11.20%	1.90%	0.00%	0.6492***	0.084	0.084
30	Bombay Stock Exchange	0.5414	0.5608	80.67%	16.81%	2.52%	0.00%	0.8396***	0.085	0.068
31	National Stock Ex. of India	0.6590	0.6679	91.89%	8.11%	0.00%	0.00%	0.7834***	0.125	0.116
32	Jakarta Stock Exchange	0.2293	0.0571	18.75%	53.13%	21.88%	6.25%	0.0431	0.080	0.018
33	KOSDAQ Market Division	0.1620	0.1339	62.50%	31.25%	6.25%	0.00%	0.1551**	0.069	0.054
34	Korea Exchange	0.4534	0.3993	63.57%	31.43%	5.00%	0.00%	0.3597***	0.110	0.089
35	Bursa Malaysia	0.3290	0.1755	22.50%	55.63%	21.25%	0.63%	0.2371***	0.024	0.013
36	Philippine Stock Exchange	0.2803	0.0121	11.11%	48.15%	37.04%	3.70%	0.0477	0.012	0.005
37	Taiwan Stock Exchange	0.9136	0.8789	84.78%	13.15%	1.73%	0.35%	0.8345***	0.147	0.092
38	Stock Ex. of Thailand	–0.0031	0.0150	7.50%	61.25%	30.00%	1.25%	0.0093	0.016	0.007
	Emerging—Europe MEA									
39	Budapest Stock Exchange	0.0455	0.0322	0.00%	69.23%	23.08%	7.69%	0.0648	0.006	0.008
40	Warsaw Stock Exchange	0.2055	0.1287	11.54%	73.08%	15.38%	0.00%	0.1365*	0.012	0.006
41	Johannesburg Stock Ex.	0.0792	0.2116	9.59%	54.79%	34.25%	1.37%	0.2936	0.003	–0.002
42	Istanbul Stock Exchange	0.4611	0.4747	83.05%	15.25%	1.69%	0.00%	0.7464***	0.062	0.042
	Emerging—Latin America									
43	Buenos Aires Stock Ex.	–0.1441	0.0077	5.26%	47.37%	36.84%	10.53%	0.0160	0.029	0.019
44	Sao Paulo Stock Exchange	–0.0599	0.0670	6.98%	51.16%	39.53%	2.33%	0.0376	0.014	0.010
45	Santiago Stock Exchange	–0.1196	–0.1123	2.44%	31.71%	63.41%	2.44%	–0.1415	0.005	–0.001
46	Mexican Stock Exchange	0.1013	0.0506	7.69%	61.54%	30.77%	0.00%	0.0213	0.007	0.002
47	Lima Stock Exchange	0.1774	0.0003	7.69%	46.15%	46.15%	0.00%	0.0940	0.012	0.010

liquidity is ubiquitous across the world's stock exchanges. Of the 47 exchanges, 43 have a positive average contemporaneous coefficient, and 46 have a positive median coefficient.[9] Some 44 exchanges have positive and significant coefficients that exceed the null hypothesis of 5%, 33 exchanges have 10% or more of their firms with positive and significant coefficients, and 23 exchanges have 20% or more of their firms with positive and significant coefficients.[10]

Turning to the percentage of firms with negative and significant contemporaneous coefficients, we find that only four exchanges (Vienna, Jakarta, Budapest, and Buenos Aires) exceed the null hypothesis of 5%. The Buenos Aires Stock Exchange is the only exchange with 10% or more of its firms (10.53%) exhibiting negative and significant coefficients. In addition to the asymmetry in significant coefficients, there is also a strong positive skewness in the percentage of firms with insignificant coefficients. All exchanges but one (Santiago) have a higher proportion of firms with positive and insignificant coefficients relative to negative and significant coefficients. For well over half of the exchanges, the percentage of firms with positive and insignificant coefficients is more than double the percentage of firms with negative and insignificant coefficients.

[9]The four exchanges with negative average coefficients include the Stock Exchange of Thailand, Buenos Aires Stock Exchange, Sao Paulo Stock Exchange, and Santiago Stock Exchange. The only exchange with a negative median coefficient is the Santiago Stock Exchange.

[10]The Budapest Stock Exchange, Santiago Stock Exchange, and JASDAQ are the only three exchanges on which less than 5% of firms have positive and significant contemporaneous coefficients.

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The median values for the sum of lead, lag, and contemporaneous coefficients are overwhelmingly positive. The Santiago Stock Exchange is the only exchange with a negative median value (−0.1415), and it is insignificant at the 5% level. Of the 46 exchanges with positive combined SUM coefficients, 29 are statistically significant at the 5% level, with 26 exchanges significant at the 1% level.

Our global data and research design also enable us to identify cross-sectional differences in spread commonality across stock exchanges. Median contemporaneous coefficients range from a low of −0.1123 for the Santiago Stock Exchange to a high of 1.1251 for the London Stock Exchange. Besides London, eight other exchanges have contemporaneous coefficients greater than 0.50; these are the stock exchanges of Toronto, NASDAQ, Tokyo, Shanghai, Shenzhen, Bombay, Taiwan, and the National Stock Exchange of India.[11] Several of these same exchanges also have a high percentage of firms with significant coefficients. The stock exchanges of Shanghai, Shenzhen, Bombay, Taiwan, Virt-X, Istanbul, and the National Stock Exchange of India all have 80% or more of their firms with positive and significant coefficients. It is interesting to note that some of the strongest patterns of commonality in liquidity appear in the emerging Asian markets.

The average and median adjusted R^2s in the last two columns reveal considerable variation in explanatory power across exchanges. The average (median) adjusted R^2 ranges from −0.003 (−0.006) for the Frankfurt Stock Exchange to 0.125 (0.116) for the National Stock Exchange of India. Most of the R^2s are comparable to the average (median) R^2 value of 0.014 (0.004) reported in Chordia et al. (2000).

In Table 3, we examine commonality in depth across 45 stock exchanges. These empirical results also provide strong support for the claim that changes in the individual firm's depth are significantly influenced by a common liquidity factor. Of the 45 exchanges, 38 have a positive average contemporaneous coefficient; 40 exchanges have a positive median coefficient. Some 43 exchanges have positive and significant coefficients that exceed the null hypothesis of 5%, while 36 exchanges have 10% or more of their firms with positive and significant coefficients. Unlike our commonality-in-spreads findings, no stock exchange has negative and significant commonality coefficients exceeding 5%. The highest percentage of negative and significant coefficients is only 3.85% from the Warsaw Stock Exchange. Similar to our commonality-in-spreads findings, the weakest evidence for commonality is concentrated on the emerging Latin American exchanges.

[11] It is interesting to note that the U.K., Japan, and Canada represent the top three destinations for U.S. portfolio investments during our sample period. According to the *Report on U.S. Portfolio Holdings of Foreign Securities* (U.S. Treasury Department, Federal Reserve Bank of New York, and Board of Governors of the Federal Reserve System (2005)), U.S. investors held portfolio investments totaling $420 billion, $255 billion, and $149 billion in the U.K., Japan, and Canada, respectively, as of December 31, 2003 (i.e., the middle of our sample period). Although another five countries (France, Switzerland, Netherlands, Bermuda, and Germany) had U.S. portfolio investments above $100 billion, investment magnitudes drop precipitously after the ninth position ($56 billion for Australia).

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TABLE 3

Exchange-Level Commonality: Depth Results

Measures are the same as in Table 2, except for the total depth in value.

#	Exchange	Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM_E Coeff.	Avg. Adj. R^2	Median Adj. R^2
	Europe									
1	Vienna Stock Exchange	0.2112	0.2036	22.22%	59.26%	18.52%	0.00%	0.3353**	0.010	–0.002
2	Copenhagen Stock Ex.	0.0162	0.1236	16.67%	45.00%	35.00%	3.33%	0.0289	0.007	0.000
3	Helsinki Stock Exchange	–0.0068	0.0007	4.84%	46.77%	48.39%	0.00%	–0.0154*	0.004	0.001
4	Euronext Paris	0.0269	0.0021	8.60%	44.34%	47.06%	0.00%	–0.0156**	0.007	–0.005
5	Deutsche Boerse	0.2082	0.2059	21.19%	52.54%	26.27%	0.00%	0.1663	0.014	0.006
6	Frankfurt Stock Exchange	0.4283	0.0631	20.00%	46.67%	33.33%	0.00%	0.0205***	–0.007	0.000
7	Athens Stock Exchange	–0.0066	–0.0028	4.44%	40.00%	55.56%	0.00%	–0.0074**	0.024	0.016
8	Irish Stock Exchange	0.1832	0.1800	12.00%	64.00%	24.00%	0.00%	0.2481***	0.011	0.009
9	Borsa Italiana	0.3874	0.2955	25.21%	54.62%	20.17%	0.00%	0.2976***	0.016	0.008
10	Oslo Stock Exchange	0.1832	0.2495	30.77%	48.08%	21.15%	0.00%	0.1893***	0.023	0.018
11	Euronext Lisbon	0.3709	0.2937	37.04%	51.85%	11.11%	0.00%	0.1277*	0.014	0.008
12	Spanish Cont. Market	3.5136	1.3870	72.00%	16.00%	12.00%	0.00%	1.5532***	0.322	0.148
13	Stockholm Stock Exchange	0.2392	0.3424	43.97%	41.38%	12.93%	1.72%	0.4571***	0.025	0.012
14	Swiss Exchange	–0.0185	0.1017	5.77%	52.88%	39.42%	1.92%	–0.0962	0.006	–0.001
15	Virt-X	0.3195	0.3243	73.08%	23.08%	3.85%	0.00%	0.2450***	0.039	0.033
16	London Stock Exchange	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	North America									
17	Toronto Stock Exchange	0.8905	0.8420	54.31%	35.14%	9.90%	0.64%	1.0900***	0.028	0.016
18	American Stock Exchange	0.0110	–0.0061	9.09%	36.36%	54.55%	0.00%	–0.0386	0.008	0.001
19	NASDAQ	0.8254	0.7291	28.68%	53.58%	17.42%	0.33%	0.7468***	0.017	0.008
20	New York Stock Exchange	0.7703	0.7951	47.43%	41.19%	11.10%	0.27%	0.8407***	0.027	0.015
	Pacific									
21	Australian Stock Exchange	0.2654	0.1305	25.51%	49.49%	22.96%	2.04%	0.0291**	0.014	0.000
22	Hong Kong Exchange	0.3208	0.3558	48.44%	37.78%	12.89%	0.89%	0.3799***	0.046	0.034
23	JASDAQ	0.1310	0.0512	8.47%	57.63%	33.90%	0.00%	0.0872*	0.008	0.007
24	Osaka Securities Exchange	0.0520	0.0359	10.14%	50.72%	39.13%	0.00%	0.1142	0.012	0.000
25	Tokyo Stock Exchange	0.5136	0.5047	39.95%	47.71%	12.01%	0.33%	0.5321***	0.021	0.012
26	New Zealand Exchange	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
27	Singapore Exchange Ltd	0.3126	0.2785	40.95%	48.57%	10.48%	0.00%	0.3107***	0.045	0.036
	Emerging—Asia									
28	Shanghai Stock Exchange	0.7824	0.7322	67.89%	27.26%	4.85%	0.00%	0.8356***	0.056	0.043
29	Shenzhen Stock Exchange	0.6710	0.6546	58.06%	37.00%	4.74%	0.19%	0.7436***	0.057	0.048
30	Bombay Stock Exchange	0.4048	0.3514	22.88%	55.08%	21.19%	0.85%	0.4325***	0.024	0.010
31	National Stock Ex. of India	0.5089	0.3833	31.82%	55.45%	11.82%	0.91%	0.4998***	0.031	0.020
32	Jakarta Stock Exchange	0.3030	0.3302	48.28%	44.83%	3.45%	3.45%	0.2391	0.049	0.038
33	KOSDAQ Market Division	0.2610	0.3055	50.00%	31.25%	18.75%	0.00%	0.3990**	0.104	0.064
34	Korea Exchange	0.1680	0.1747	30.71%	51.43%	17.86%	0.00%	0.1204***	0.074	0.059
35	Bursa Malaysia	1.4947	1.0664	97.50%	1.87%	0.63%	0.00%	1.0759***	0.852	0.937
36	Philippine Stock Exchange	0.2937	0.3128	37.04%	48.15%	14.81%	0.00%	0.3401***	0.024	0.023
37	Taiwan Stock Exchange	0.5963	0.5566	71.63%	25.26%	3.11%	0.00%	0.5997***	0.063	0.055
38	Stock Ex. of Thailand	0.7348	0.7574	72.50%	21.25%	6.25%	0.00%	0.8965***	0.058	0.053
	Emerging—Europe MEA									
39	Budapest Stock Exchange	0.1861	0.2313	46.15%	23.08%	30.77%	0.00%	0.4057	0.011	0.002
40	Warsaw Stock Exchange	0.2139	0.2790	42.31%	38.46%	15.38%	3.85%	0.1974	0.024	0.013
41	Johannesburg Stock Ex.	1.0312	0.8344	35.82%	43.28%	19.40%	1.49%	1.2190**	0.007	0.002
42	Istanbul Stock Exchange	0.8078	0.8865	88.14%	8.47%	3.39%	0.00%	0.8645***	0.183	0.196
	Emerging—Latin America									
43	Buenos Aires Stock Ex.	0.3334	0.3094	47.37%	52.63%	0.00%	0.00%	0.5166***	0.024	0.015
44	Sao Paulo Stock Exchange	0.3434	–0.0212	6.67%	35.56%	57.78%	0.00%	0.0025	0.026	–0.006
45	Santiago Stock Exchange	–0.0468	0.1577	17.07%	41.46%	39.02%	2.44%	0.0800	–0.001	0.001
46	Mexican Stock Exchange	–0.0297	–0.0054	5.13%	33.33%	61.54%	0.00%	–0.0149	0.008	–0.003
47	Lima Stock Exchange	–0.0016	–0.0017	7.69%	30.77%	61.54%	0.00%	0.0004	0.001	0.004

The median values for the sum of lead, lag, and contemporaneous depth coefficients are mostly positive and significant. Of the 39 exchanges with positive combined SUM coefficients, 28 are statistically significant at the 5% level, and

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24 exchanges are significant at the 1% level. Only two exchanges, Euronext Paris and the Athens Stock Exchange, have negative median SUM values (−0.0156 and −0.0074, respectively) that are significant at the 5% level.

Similar to the cross-sectional differences in spread commonality, we find considerable variation in depth commonality across stock exchanges.[12] Median contemporaneous coefficients vary from a low of −0.0212 for the Sao Paulo Stock Exchange to a high of 1.3870 for the Spanish Continuous Market.[13] In addition to the Spanish exchange, 11 other exchanges have contemporaneous median coefficients greater than 0.50; six of these 11 exchanges are located in emerging Asia.[14] Consistent with the cross-section differences in contemporaneous depth coefficients, the average and median R^2 values also show considerable variation across exchanges.

In Table 4, we aggregate our spread and depth findings by geographic region and by emerging versus developed markets. Panel A reports the bid-ask spread results at the global, developed, and emerging market levels. We use the MSCI categories to further divide our developed markets into European, North American, and Pacific regions, and our emerging markets into Asian, Latin American, and Europe, Middle East, and Africa regions. Panel B follows the same format for depths.

Turning to the results in Panel A of Table 4, we find that the average (median) contemporaneous spread coefficient is 0.5986 (0.4271). These positive coefficients are significant at the 5% level for 48.78% of the firms in our global database. The median of the combined lead, lag, and contemporaneous coefficient is 0.4327 and highly significant. The average (median) adjusted R^2 is 0.043 (0.026).

We find this same general pattern in the developed markets, where the average (median) contemporaneous spread coefficient is 0.6036 (0.3733). Almost

[12]We note that our average NYSE contemporaneous spread (depth) coefficient is 0.3550 (0.7703) compared to Chordia et al.'s (2000) average NYSE spread (depth) coefficient of 0.7780 (1.3730) based on 1992 data. To investigate these differences, we estimate average NYSE spread and depth coefficients for each year from 1993 to 2003. We find considerable intertemporal variation. Average annual spread coefficients vary from 0.0273 to 0.9284, and average annual depth coefficients range from 0.6658 to 1.7078. Identifying the causes of such intertemporal variation is a potential topic for future research.

[13]We also note the extremely high percentage of positive and significant contemporaneous depth coefficients (97.5%) for Bursa Malaysia. According to its 2003 annual report, the Bursa Malaysia Exchange had reduced its standard lot size to 100 units for all stocks beginning in April 2003 from an earlier three-tiered standard of 1,000, 200, and 100 units. Because our sample period spans this change in lot sizes, we test the pre- and post-change periods separately. We find that the median contemporaneous depth coefficient increases from 0.0495 in the pre-change period to 1.0560 in the post-change period. The percentage of firms with positive and significant coefficients increases from 6.88% to 97.5% over the same pre- versus post-period. This evidence suggests that a reduction in standard lot sizes will result in higher depth commonality.

[14]As a robustness check, Chordia et al. (2000) test for cross-equation dependencies by running time-series regressions on the residuals of paired companies. They report that the mean level of dependency is insufficient to significantly affect their overall results. We apply the same method and run time-series regressions on the residuals of randomly arranged adjacent companies. At the 5% level, the proportion of significant t-values are 4.32% and 4.27% for our spread and depth residual regressions, respectively. These figures are lower than the comparable numbers, 12.33% and 11.73%, respectively, reported by Chordia et al. (2000). We obtain similar robustness results (i.e., relatively low levels of cross-equation dependencies) for all subsequent findings.

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TABLE 4

Exchange-Level Commonality

Firm-by-firm (9,427) time-series regressions of liquidity measures are estimated using regression (1):

$$(1)\quad \Delta\text{LIQUIDITY}_{F,t} = \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1} + \delta_3 \text{RETURN}_{E,t-1} + \delta_4 \Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t}.$$

$\text{LIQUIDITY}_{F,t}$ is the relative effective spread (Panel A of Table 4) and the total depth in value (Panel B) of firm F on day t. $\text{LIQUIDITY}_{E,t}$ is the exchange-level liquidity index, and $\text{RETURN}_{E,t}$ is the exchange-level return computed on day t using an equal-weighted average of each corresponding liquidity measure and return, respectively, for all firms trading on the same exchange, except firm F. $\text{VOLATILITY}_{F,t}$ is the return volatility for firm F on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. We present the average and median coefficient estimate of the exchange-level liquidity beta β_1, along with the percentage of firms for which β_1 is positive and significant at the 5% confidence level (t-statistic > 1.645), positive and not significant at the 5% confidence level, negative and not significant at the 5% confidence level, and negative and significant at the 5% confidence level, respectively. We report in the last three columns the median of the sum of the contemporaneous, lead, and lag coefficient estimates ($\text{SUM}_E = \beta_1 + \beta_2 + \beta_3$), and the average- and median-adjusted R^2s. Here, *, **, and *** indicate that the hypothesis median (SUM_E) = 0 is rejected by a sign test at the 10%, 5%, and 1% confidence levels, respectively.

Geographic Region	Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM_E Coeff.	Avg. Adj. R^2	Median Adj. R^2
Panel A. Spread									
World (all exchanges)	0.5986	0.4271	48.78%	37.52%	13.06%	0.64%	0.4327***	0.043	0.026
Developed markets									
Europe	0.4992	0.2526	24.81%	53.03%	21.18%	0.98%	0.2776***	0.019	0.010
North America	0.6529	0.4563	47.88%	39.42%	12.28%	0.42%	0.4447***	0.031	0.022
Pacific	0.6123	0.3426	49.58%	37.42%	12.10%	0.90%	0.3558***	0.046	0.030
All developed markets	0.6036	0.3733	42.59%	42.27%	14.45%	0.69%	0.3783***	0.032	0.020
Emerging markets									
Asia	0.6586	0.6357	73.61%	20.44%	5.67%	0.29%	0.6134***	0.086	0.071
Europe, Middle East, Africa	0.2276	0.3010	34.50%	45.03%	19.30%	1.17%	0.4628***	0.025	0.010
Latin America	–0.0255	0.0100	5.81%	47.74%	43.87%	2.58%	0.0083	0.012	0.008
All emerging markets	0.5845	0.5677	66.52%	23.92%	9.07%	0.49%	0.5703***	0.077	0.061
Panel B. Depth									
World (all exchanges)	0.6205	0.5204	41.54%	42.60%	15.46%	0.40%	0.5343***	0.047	0.016
Developed markets									
Europe	0.3610	0.0815	22.78%	45.38%	31.31%	0.53%	0.0444***	0.034	0.006
North America	0.7946	0.7638	38.86%	46.38%	14.41%	0.36%	0.8082***	0.022	0.011
Pacific	0.4232	0.3979	37.40%	47.17%	14.89%	0.54%	0.3827***	0.024	0.012
All developed markets	0.6082	0.4924	35.54%	46.43%	17.59%	0.44%	0.4828***	0.025	0.011
Emerging markets									
Asia	0.6876	0.6141	60.65%	32.47%	6.69%	0.19%	0.6828***	0.116	0.049
Europe, Middle East, Africa	0.7559	0.6952	56.36%	28.48%	13.94%	1.21%	0.7638***	0.072	0.021
Latin America	0.1191	0.0011	14.01%	38.22%	47.13%	0.64%	0.0025	0.012	–0.001
All emerging markets	0.6553	0.5792	57.33%	32.57%	9.81%	0.29%	0.6496***	0.106	0.044

43% of the developed market firms have positive and significant coefficients. The average (median) adjusted R^2 is 0.032 (0.020). Among the three regions, North American firms are more susceptible to commonality in liquidity than their European counterparts, according to both contemporaneous coefficient and adjusted R^2 values.

For the emerging markets, the average (median) contemporaneous spread coefficient is 0.5845 (0.5677). Over 66% of the emerging market firms have positive and significant coefficients. In sharp contrast to the developed markets, emerging markets exhibit large variations in spread commonality. There is no evidence of spread commonality in the Latin American region, whether one looks

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at the average or median contemporaneous coefficients, the percentage of firms with significant coefficients, or the combined lead, lag, and contemporaneous coefficient.[15] Similarly, the Latin American region R^2 values are the lowest among emerging markets. The Asian emerging markets, on the other hand, have the largest commonality coefficients (average, median, and combined), the highest percent of significant coefficients, and the highest adjusted R^2s across all regions, including the developed markets.

In Panel B of Table 4, we report parallel results for our depth measures. The average (median) contemporaneous depth coefficient is 0.6205 (0.5204), and these coefficients are significant for 41.54% of global firms. The median of the combined lead, lag, and contemporaneous coefficient is 0.5343 and highly significant. Similar to the spread results in Panel A, the developed market's contemporaneous and combined coefficients are positive and highly significant. Again, the North American firms appear to be more susceptible to commonality in liquidity than their European counterparts. Unlike the spread results in Panel A, all emerging markets display significant commonality in depth liquidity, with the exception of Latin America's combined coefficient. The emerging areas of Europe, Middle East, and Africa have large and highly significant contemporaneous depth coefficients, although the Asian region has the highest adjusted R^2s.[16] Overall, we find that the adjusted spread (Panel A) and depth (Panel B) R^2s are higher for the emerging markets than for the developed markets.

1. Exchange-Level Commonality: Size Effects

In Table 5, we examine the relation between firm size (i.e., market capitalization) and commonality.[17] Our spread results in Panel A show that average, median, and combined SUM coefficients are overwhelmingly positive and significant across all size quintiles. Firms in the second-smallest size quintile (Quintile 2) have the highest mean and median coefficients (0.7231 and 0.6164, respectively), while firms in the largest size quintile (Quintile 5) have the smallest mean and median coefficients (0.3986 and 0.2142, respectively). The parametric t-test (nonparametric Wilcoxon rank-sum test) rejects equality at the 1% confidence level for the largest-versus-smallest quintile portfolios.

These global findings contrast rather sharply with previous size-based results looking at NYSE firms. Chordia et al. (2000) find that large NYSE firms

[15] It should be noted that the Latin American region experienced a currency crisis during our sample period. The Argentine peso, for example, had been pegged to the U.S. dollar on a one-to-one basis through a currency board arrangement since the early 1990s. Beginning in 2002, the exchange rate changed dramatically from one peso per dollar to over three pesos per dollar. Similar, if less dramatic, changes occurred for the Brazilian real. It is possible that our Latin American commonality outcomes are the result of these financial market convulsions. Eichengreen, Gupta, and Mody (2006), for example, show that currency crises lead to "sudden stops" in capital flows.

[16] Because our commonality results are multidimensional (i.e., both spreads and depths have mean, median, and percent positive and significant values), it is difficult to unambiguously rank all markets according to commonality. We do observe among developed markets, however, that the North American markets display unambiguously stronger commonality patterns than the European markets.

[17] We also form portfolio quintiles on an exchange-by-exchange basis (i.e., quintiles are first formed separately within each exchange and then combined, pooling all firms in the same quintile across the exchanges). The results from this alternative method are very similar to those reported in Table 5.

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TABLE 5

Exchange-Level Commonality: Results by Size Quintile

Firm-by-firm (9,427) time-series regressions of liquidity measures are estimated using regression (1):

$$(1)\quad \Delta\text{LIQUIDITY}_{F,t} = \alpha + \beta_1\Delta\text{LIQUIDITY}_{E,t} + \beta_2\Delta\text{LIQUIDITY}_{E,t+1} + \beta_3\Delta\text{LIQUIDITY}_{E,t-1} + \delta_1\text{RETURN}_{E,t} + \delta_2\text{RETURN}_{E,t+1} + \delta_3\text{RETURN}_{E,t-1} + \delta_4\Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t}.$$

$\text{LIQUIDITY}_{F,t}$ is the relative effective spread (Panel A of Table 5) and the total depth in value (Panel B) of firm F on day t. $\text{LIQUIDITY}_{E,t}$ is the exchange-level liquidity index, and $\text{RETURN}_{E,t}$ is the exchange-level return computed on day t using an equal-weighted average of each corresponding liquidity measure and return, respectively, for all firms trading on the same exchange, except firm F. $\text{VOLATILITY}_{F,t}$ is the return volatility for firm F on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. We present the average and median coefficient estimate of the exchange-level liquidity beta β_1, along with the percentage of firms for which β_1 is positive and significant at the 5% confidence level (t-statistic > 1.645), positive and not significant at the 5% confidence level, negative and not significant at the 5% confidence level, and negative and significant at the 5% confidence level, respectively. We report in the last three columns the median of the sum of the contemporaneous, lead, and lag coefficient estimates ($\text{SUM}_E = \beta_1 + \beta_2 + \beta_3$), and the average- and median-adjusted R^2s. Here, *, **, and *** indicate that the hypothesis median (SUM_E) = 0 is rejected by a sign test at the 10%, 5%, and 1% confidence levels, respectively. Results are presented by firm size quintiles, and quintiles are formed globally across all sample firms. The superscript [a(b)] indicates that the hypothesis for equality of means (medians) between the Quintile 1 portfolio and the Quintile 5 portfolio is rejected in a parametric t-test (nonparametric Wilcoxon rank-sum test) at the 1% confidence level.

Firm Portfolios	Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM_E Coeff.	Avg. Adj. R^2	Median Adj. R^2
Panel A. Spread									
Quintile 1 (smallest firms)	0.6909[a]	0.5215[b]	45.14%	38.89%	15.06%	0.91%	0.5648***	0.041	0.023
Quintile 2	0.7231	0.6164	56.91%	32.75%	9.87%	0.48%	0.5990***	0.049	0.032
Quintile 3	0.6744	0.5267	57.04%	31.98%	10.61%	0.37%	0.5357***	0.046	0.030
Quintile 4	0.5062	0.3702	48.35%	37.57%	13.45%	0.64%	0.3558***	0.039	0.023
Quintile 5 (largest firms)	0.3986[a]	0.2142[b]	36.46%	46.43%	16.31%	0.80%	0.2176***	0.043	0.021
Panel B. Depth									
Quintile 1 (smallest firms)	0.5016	0.3339[b]	27.26%	46.97%	24.69%	1.09%	0.3305***	0.048	0.009[b]
Quintile 2	0.5930	0.4742	34.93%	47.26%	17.35%	0.45%	0.5324***	0.043	0.014
Quintile 3	0.6318	0.5446	39.44%	44.05%	16.39%	0.11%	0.5519***	0.044	0.014
Quintile 4	0.6362	0.5711	44.22%	43.82%	11.72%	0.23%	0.5728***	0.045	0.016
Quintile 5 (largest firms)	0.7416	0.6876[b]	62.14%	30.69%	7.05%	0.12%	0.6574***	0.057	0.030[b]

have the highest commonality-in-spread coefficients. On the other hand, these global commonality-in-spread coefficients are consistent with the size-based findings for an order-driven, non-U.S. stock exchange (e.g., the Stock Exchange of Hong Kong) in Brockman and Chung (2002).

Our Panel B of Table 5 depth results show that average, median, and combined SUM coefficients are positive and significant across all size quintiles. Firms in the largest size quintile have the highest mean and median coefficients (0.7416 and 0.6876, respectively), while firms in the smallest size quintile have the smallest mean and median coefficients (0.5016 and 0.3339, respectively). Unlike the spread results in Panel A, our depth results show a clear, monotonically increasing relation between firm size and commonality in depths. In addition, the differences across depth quintile portfolios are less significant than their spread counterparts in Panel A.

Overall, these findings show that commonality is prevalent across all firm sizes; small firms are more susceptible to commonality in spreads than large firms, but large firms experience more commonality in depths than small firms.

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2. Exchange-Level Commonality: Industry Effects

We test for industry-wide commonality at the exchange level by using the following regression model:

$$\begin{aligned}(2)\qquad \Delta\text{LIQUIDITY}_{F,t} = {} & \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} \\ & + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} + \gamma_1 \Delta\text{LIQUIDITY}_{\text{EI},t} \\ & + \gamma_2 \Delta\text{LIQUIDITY}_{\text{EI},t+1} + \gamma_3 \Delta\text{LIQUIDITY}_{\text{EI},t-1} \\ & + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1} + \delta_3 \text{RETURN}_{E,t-1} \\ & + \delta_4 \Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t},\end{aligned}$$

where $\text{LIQUIDITY}_{\text{EI},t}$ (i.e., exchange-level industry liquidity) is the equal-weighted average of the respective liquidity measure for all firms in the industry. All other variables are the same as defined above in model (1). Our primary variable of interest in regression model (2) is the contemporaneous coefficient on $\Delta\text{LIQUIDITY}_{\text{EI},t}$.

In Table 6, we report commonality in liquidity results at the industry level while controlling for commonality in liquidity at the exchange level (i.e., regression model (2)).[18] We report the spread coefficients in Panel A and the depth coefficients in Panel B. For the spread results in Panel A, our average (median) contemporaneous coefficient related to industry commonality is 0.1064 (0.0334). Over 10% of all firms have positive and significant contemporaneous coefficients, and the SUM coefficient of 0.0344 is highly significant. We find similar results for both the 27 developed and 20 emerging markets. The median coefficients are 0.0340 and 0.0304, respectively, and they are significant for 10.07% and 11.73% of all in-sample firms, respectively. Similar to our non-industry-adjusted findings in Table 4, emerging markets' adjusted R^2s are larger than developed markets' adjusted R^2s.

For the depth results in Panel B of Table 6, our average (median) contemporaneous coefficient related to industry commonality is 0.1315 (0.0749). Over 13% of all firms have positive and significant contemporaneous coefficients, and the SUM coefficient of 0.0799 is highly significant. Again, we find similar results for the developed and emerging markets. The median coefficients are 0.0787

[18] In addition, we examine exchange-level industry commonality by aggregating regression model (1) results across our 10 industries (basic materials, communications, consumer cyclicals, consumer noncyclicals, diversified, energy, financials, industrials, technology, and utilities). The spread results reveal positive and highly significant mean, median, and SUM coefficients. The percentage of firms with positive and significant contemporaneous spread coefficients (at the 5% level) varies from a low of 32.51% for utilities to a high of 58.65% for consumer noncyclicals. Every industry has a highly significant and positive median sum of lead, lag, and contemporaneous coefficients (all p-values less than 0.001). Similar to the spread results, the mean and median contemporaneous depth coefficients are all positive and highly significant. The percentage of firms with positive and significant contemporaneous depth coefficients varies from a low of 23.44% for the basic material industry to a high of 74.23% for utilities. All of the combined SUM coefficients are positive and significant at the 5% level. Overall, these results show that our commonality results are not driven by a small number of industries.

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TABLE 6

Exchange-Level and Industry Commonality

Firm-by-firm (9,427) time-series regressions of liquidity measures are estimated using regression (2):

$$\begin{aligned}(2)\qquad \Delta\text{LIQUIDITY}_{F,t} &= \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} \\ &\quad + \gamma_1 \Delta\text{LIQUIDITY}_{\text{EI},t} + \gamma_2 \Delta\text{LIQUIDITY}_{\text{EI},t+1} + \gamma_3 \Delta\text{LIQUIDITY}_{\text{EI},t-1} \\ &\quad + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1} + \delta_3 \text{RETURN}_{E,t-1} + \delta_4 \Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t}.\end{aligned}$$

$\text{LIQUIDITY}_{F,t}$ is the relative effective spread (Panel A of Table 6) and the total depth in value (Panel B) of firm F on day t. $\text{LIQUIDITY}_{E,t}$ is the exchange-level liquidity index, and $\text{RETURN}_{E,t}$ is the exchange-level return computed on day t using an equal-weighted average of each corresponding liquidity measure and return, respectively, for all firms trading on the same exchange, except firm F. $\text{LIQUIDITY}_{\text{EI},t}$ is the industry-level liquidity index computed on day t using an equal-weighted average of each corresponding liquidity measure for all firms in firm F's industry. $\text{VOLATILITY}_{F,t}$ is the return volatility for firm F on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. We present the average and median coefficient estimate of the exchange-level and industry-level liquidity betas β_1, and γ_1, along with the percentage of firms for which β_1, or γ_1, is positive and significant at the 5% confidence level (t-statistic > 1.645), positive and not significant at the 5% confidence level, negative and not significant at the 5% confidence level, and negative and significant at the 5% confidence level, respectively. We report in the last three columns the median of the sum of the contemporaneous, lead, and lag coefficient estimates ($\text{SUM}_E = \beta_1 + \beta_2 + \beta_3$ and $\text{SUM}_{\text{EI}} = \gamma_1 + \gamma_2 + \gamma_3$), and the average- and median-adjusted R^2s. Here, *, **, and *** indicate that the hypotheses median (SUM_E) = 0 and median (SUM_{EI}) = 0 are rejected by a sign test at the 10%, 5%, and 1% confidence levels, respectively.

Firm Portfolios		Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM_E Coeff.	Avg. Adj. R^2	Median Adj. R^2
Panel A. Spread										
World (all exchanges)	β_1	0.4966	0.3377	29.91%	49.61%	19.32%	1.16%	0.3157***	0.046	0.029
	γ_1	0.1064	0.0334	10.50%	47.65%	38.58%	3.27%	0.0344***		
All developed markets	β_1	0.4796	0.2864	24.58%	52.88%	21.23%	1.32%	0.2710***	0.034	0.022
	γ_1	0.1254	0.0340	10.07%	48.09%	38.79%	3.05%	0.0331***		
All emerging markets	β_1	0.5456	0.4855	45.26%	40.22%	13.81%	0.71%	0.4527***	0.079	0.065
	γ_1	0.0518	0.0304	11.73%	46.38%	37.98%	3.91%	0.0375***		
Panel B. Depth										
World (all exchanges)	β_1	0.4983	0.4052	27.02%	50.01%	21.89%	1.09%	0.3932***	0.045	0.050
	γ_1	0.1315	0.0749	13.25%	47.66%	36.10%	3.00%	0.0799***		
All developed markets	β_1	0.4690	0.3644	21.99%	52.28%	24.47%	1.25%	0.3122***	0.039	0.028
	γ_1	0.1468	0.0787	12.80%	47.91%	36.53%	2.77%	0.0854***		
All emerging markets	β_1	0.5753	0.4934	40.23%	44.01%	15.09%	0.67%	0.5439***	0.075	0.110
	γ_1	0.0912	0.0662	14.42%	47.01%	34.95%	3.62%	0.0711***		

and 0.0662, respectively, and they are significant for 12.80% and 14.42% of in-sample firms, respectively. As in Panel A, the adjusted R^2s are larger for emerging markets than for developed markets.

Overall, the results in Table 6 demonstrate that there is a significant industry component in firm-level liquidity. The industry component is present in spreads and depths, as well as in developed and emerging markets. However, industry-level commonality is not as influential as the exchange-level component in terms of average, median, or SUM coefficient magnitudes or significance levels. Comparing our findings to Chordia et al.'s (2000) NYSE findings, we note that the industry effect is much more prominent for NYSE firms than for the typical global firm. For three of their five liquidity measures, Chordia et al. (2000) find that contemporaneous and SUM industry coefficients are larger than the respective exchange-level (i.e., NYSE) coefficients. The industry coefficients for NYSE

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firms are also much larger than for our global firms.[19] Although these differences could be related to the specialist market structure (Coughenour and Saad (2004)), further research is certainly warranted.

B. Global Commonality

Our exchange-level results provide direct evidence that the commonality in liquidity found in previous studies of the NYSE is in fact a pervasive phenomenon across most of the world's stock exchanges. We also document cross-sectional variations in commonality at the level of the individual exchange, geographic region (e.g., Pacific, Latin America), developed versus emerging market, size-based quintiles, and industry. We turn now to examining commonality at the global scale. Our primary objective in this section is to determine whether commonality in liquidity has a natural boundary at the exchange's frontier, or whether it spills over onto other exchanges and firms.

1. Global Commonality: Comovement across Exchanges

In the second section of our analysis, we extend the methodology of Chordia et al. (2000) to capture the influence of global commonality on exchange-level liquidity. We test for a global commonality influence on exchange-level liquidity by estimating the following time-series regression:

$$\begin{aligned}(3)\qquad \Delta\text{LIQUIDITY}_{E,t} &= \alpha + \beta_1 \Delta\text{LIQUIDITY}_{G,t} + \beta_2 \Delta\text{LIQUIDITY}_{G,t+1} \\ &\quad + \beta_3 \Delta\text{LIQUIDITY}_{G,t-1} + \delta_1 \text{RETURN}_{G,t} + \delta_2 \text{RETURN}_{G,t+1} \\ &\quad + \delta_3 \text{RETURN}_{G,t-1} + \delta_4 \Delta\text{VOLATILITY}_{E,t} + \varepsilon_{E,t},\end{aligned}$$

where $\text{LIQUIDITY}_{G,t}$ and $\text{RETURN}_{G,t}$ are equal-weighted averages across all firms in our global database, except those firms trading on exchange E. The primary variable of interest in regression model (3) is the contemporaneous coefficient on $\Delta\text{LIQUIDITY}_{G,t}$. A positive and significant β_1 would mean that global liquidity changes exert a substantial influence on exchange E's liquidity.

In Table 7, we investigate the global scope of commonality in liquidity. We use regression model (3) to estimate changes in aggregate exchange liquidity attributable to changes in global liquidity. Panel A reports our spread results, and Panel B provides our depth results. The average (median) contemporaneous spread coefficient is 0.1753 (0.1764) across all stock exchanges. This coefficient is positive and significant at the 5% level for 44.68% of our exchanges. It is negative and significant for 2.13% of all exchanges. The median sum of lead, lagged, and contemporaneous coefficients is 0.2275, and it is highly significant. These findings represent unambiguous evidence of global commonality in bid-ask spreads.

We investigate global commonality in more detail by dividing our 47 exchanges into 27 developed markets and 20 emerging markets. This partition

[19]The industry-related spread SUM coefficients for NYSE firms range from a low of 0.259 for relative effective spreads to a high of 0.527 for quoted spreads. The industry-related depth SUM coefficient for NYSE firms is 0.480. In contrast, none of our comparable spread coefficients is larger than 0.0375, and none of our depth SUM coefficients is larger than 0.0854.

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TABLE 7

Global Commonality

Exchange-by-exchange (47) time-series regressions of liquidity measures are estimated using regression (3):

$$(3)\quad \Delta\text{LIQUIDITY}_{E,t} = \alpha + \beta_1 \Delta\text{LIQUIDITY}_{G,t} + \beta_2 \Delta\text{LIQUIDITY}_{G,t+1} + \beta_3 \Delta\text{LIQUIDITY}_{G,t-1} + \delta_1 \text{RETURN}_{G,t} + \delta_2 \text{RETURN}_{G,t+1} + \delta_3 \text{RETURN}_{G,t-1} + \delta_4 \Delta\text{VOLATILITY}_{E,t} + \varepsilon_{E,t}.$$

$\text{LIQUIDITY}_{E,t}$ is the exchange-level average relative effective spread (Panel A of Table 7) and total depth in value (Panel B) of exchange E on day t. $\text{LIQUIDITY}_{G,t}$ is the global liquidity index, and $\text{RETURN}_{G,t}$ is the global return computed on day t using an equal-weighted average of each corresponding liquidity measure and return, respectively, for all firms, except those firms trading on exchange E. $\text{VOLATILITY}_{E,t}$ is the return volatility for firms trading on exchange E on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. We present the average and median coefficient estimate of the exchange-level liquidity beta β_1, along with the percent of firms for which β_1 is positive and significant at the 5% confidence level (t-statistic > 1.645), positive and not significant at the 5% confidence level, negative and not significant at the 5% confidence level, and negative and significant at the 5% confidence level, respectively. We report in the last three columns the median of the sum of the contemporaneous, lead, and lag coefficient estimates ($\text{SUM}_G = \beta_1 + \beta_2 + \beta_3$), and the average- and median-adjusted R^2s. Here, *, **, and *** indicate that the hypothesis median (SUM_G) = 0 is rejected by a sign test at the 10%, 5%, and 1% confidence levels, respectively.

Exchange Portfolios	Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM_G Coeff.	Avg. Adj. R^2	Median Adj. R^2
Panel A. Spread									
World (all exchanges)	0.1753	0.1764	44.68%	38.30%	14.89%	2.13%	0.2275***	0.039	0.037
Developed markets	0.2494	0.2440	59.26%	25.93%	14.81%	0.00%	0.2546***	0.038	0.034
Emerging markets	0.0752	0.1296	25.00%	55.00%	15.00%	5.00%	0.1234**	0.040	0.041
Panel B. Depth									
World (all exchanges)	0.0674	0.0352	26.67%	46.67%	22.22%	4.44%	0.0750***	0.051	0.029
Developed markets	0.0711	0.0404	32.00%	40.00%	24.00%	4.00%	0.1055*	0.048	0.020
Emerging markets	0.0628	0.0325	20.00%	55.00%	20.00%	5.00%	0.0614	0.056	0.029

allows us to analyze separately the global components in developed versus emerging markets, although it also reduces the power of our tests by creating two small samples. The developed markets average (median) contemporaneous spread coefficient is 0.2494 (0.2440). Almost 60% of these coefficients are positive and significant, and none is negative and significant. The SUM coefficient (0.2546) is significant at the 1% level. Our emerging markets results are similar in significance, if smaller in magnitude. The emerging markets average (median) contemporaneous spread coefficient is 0.0752 (0.1296). Of these coefficients, 25% are positive and significant, and 5% are negative and significant. The median SUM coefficient (0.1234) is significant at the 5% level. Overall, we find that changes in bid-ask spreads strongly covary across both developed and emerging markets.

Turning to the depth results in Panel B of Table 7, we see that the average (median) contemporaneous depth coefficient is 0.0674 (0.0352) across all stock exchanges. This coefficient is positive and significant for 26.67% of our exchanges, and negative and significant for 4.44% of our exchanges. The median SUM coefficient is 0.0750, and it is significant at the 1% level.

The developed markets average (median) contemporaneous depth coefficient is 0.0711 (0.0404). Of these coefficients, 32% are positive and significant, while only 4% are negative and significant. The SUM coefficient (0.1055) is positive and significant at the 5.2% level. The emerging markets average (median) contemporaneous depth coefficient is 0.0628 (0.0325). Of these coefficients, 20% are

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positive and significant, and 5% are negative and significant. The median SUM coefficient (0.0614) is positive but insignificant at conventional levels.

Overall, our Table 7 findings represent the first empirical evidence of global commonality in spreads and depths. Global commonality in spreads and depths significantly affects both developed and emerging markets.[20] Although the magnitudes of developed markets' coefficients are larger than those of the emerging markets, the adjusted R^2s of the emerging markets are larger than those of the developed markets.[21]

2. Global Commonality: Size Effects

In Table 8, we report global commonality coefficients by exchange size in order to test whether commonality is restricted to exchanges of a given size. We divide all 47 exchanges into small, medium, and large categories based on their total market capitalizations. The spread results in Panel A demonstrate that while spread commonality is significant across all exchange sizes, larger exchanges are more sensitive to liquidity spillover than small exchanges. The average (median) contemporaneous coefficient increases from 0.1664 (0.1296) for small exchanges to 0.2011 (0.2075) for large exchanges. Similarly, the percentage of exchanges with positive and significant coefficients is 31.25% for small exchanges and 68.7% for large exchanges, with medium-sized exchanges somewhere in between. In contrast to Table 5's firm-size results, where spread commonality decreases with size, our exchange-based results show that spread commonality increases with size. The adjusted R^2 values follow this same general pattern.

The depth results in Panel B of Table 8 reveal that depth commonality is significant across all exchange sizes. Small exchanges are relatively more sensitive to depth-related liquidity spillover than large exchanges. The average (median) contemporaneous coefficient decreases from 0.0926 (0.0812) for small exchanges to 0.0329 (0.0348) for large exchanges. Similarly, the percentage of exchanges with positive and significant coefficients is 31.25% for small exchanges and 20.00% for large exchanges, with medium-sized exchanges in between. Unlike the consistency between coefficients and R^2s in Panel A (i.e., both increase with exchange size), depth coefficients decrease with exchange size, while R^2 increases with exchange size.

The size of the exchange, in terms of market capitalization, appears to play a significant role in liquidity transmission. Larger exchanges experience greater spillover effects in the spread dimension, while the exchange size–spillover effect

[20]Following Chordia et al. (2000), we test for cross-equation dependencies by running time-series regressions on the residuals of paired exchanges. At the 5% level, the proportions of significant t-values are 6.52% and 9.09% for our spread and depth residual regressions, respectively. These figures are lower than the firm-level NYSE results reported in Chordia et al. (2000).

[21]We rerun all of the results in Table 7 after excluding the effect of several influential exchanges; NYSE, NASDAQ, the London Stock Exchange, and the Tokyo Stock Exchange. Although there is a reduction in the magnitudes and significance levels after excluding these four largest exchanges, commonality in global liquidity remains significant for both spreads and depths. Overall, our robustness tests show that global commonality is not driven solely by New York, London, or Tokyo.

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TABLE 8

Global Commonality and Exchange Size

Exchange-by-exchange (47) time-series regressions of liquidity measures are estimated using regression (3):

$$(3)\quad \Delta\text{LIQUIDITY}_{E,t} = \alpha + \beta_1 \Delta\text{LIQUIDITY}_{G,t} + \beta_2 \Delta\text{LIQUIDITY}_{G,t+1} + \beta_3 \Delta\text{LIQUIDITY}_{G,t-1} + \delta_1 \text{RETURN}_{G,t} + \delta_2 \text{RETURN}_{G,t+1} + \delta_3 \text{RETURN}_{G,t-1} + \delta_4 \Delta\text{VOLATILITY}_{E,t} + \varepsilon_{E,t}.$$

$\text{LIQUIDITY}_{E,t}$ is the exchange-level average relative effective spread (Panel A of Table 8) and total depth in value (Panel B) of exchange E on day t. $\text{LIQUIDITY}_{G,t}$ is the global liquidity index, and $\text{RETURN}_{G,t}$ is the global return computed on day t using an equal-weighted average of each corresponding liquidity measure and return, respectively, for all firms, except those firms trading on exchange E. $\text{VOLATILITY}_{E,t}$ is the return volatility for firms trading on exchange E on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. We present the average and median coefficient estimate of the exchange-level liquidity beta β_1, along with the percentage of firms for which β_1 is positive and significant at the 5% confidence level (t-statistic > 1.645), positive and not significant at the 5% confidence level, negative and not significant at the 5% confidence level, and negative and significant at the 5% confidence level, respectively. We report in the last three columns the median of the sum of the contemporaneous, lead, and lag coefficient estimates ($\text{SUM}_G = \beta_1 + \beta_2 + \beta_3$), and the average- and median-adjusted R^2s. Here, *, **, *** indicate that the hypothesis median (SUM_G) = 0 is rejected by a sign test at the 10%, 5%, and 1% confidence levels, respectively. Results are presented for the 16 smallest exchanges, 15 medium-sized exchanges, and 16 largest exchanges.

Exchange Portfolios	Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM_G Coeff.	Avg. Adj. R^2	Median Adj. R^2
Panel A. Spread									
Small markets	0.1664	0.1296	31.25%	50.00%	18.75%	0.00%	0.2564*	0.035	0.026
Medium markets	0.1572	0.1765	33.33%	46.67%	13.33%	6.67%	0.1282	0.037	0.044
Large markets	0.2011	0.2075	68.75%	18.75%	12.50%	0.00%	0.2410**	0.044	0.041
Panel B. Depth									
Small markets	0.0926	0.0812	31.25%	50.00%	18.75%	0.00%	0.1344*	0.043	0.022
Medium markets	0.0758	0.0315	28.57%	28.57%	35.71%	7.14%	0.0481	0.020	0.011
Large markets	0.0329	0.0348	20.00%	60.00%	13.33%	6.67%	0.0635*	0.089	0.062

is more complicated for depths.[22] The main finding in Table 8, however, is that all exchange sizes are susceptible to global commonality in liquidity.

3. Global Commonality: Regional Effects

Next, we test for regional effects in liquidity using the following regression model:

$$\begin{aligned}(4)\quad \Delta\text{LIQUIDITY}_{E,t} &= \alpha + \beta_1 \Delta\text{LIQUIDITY}_{G,t} + \beta_2 \Delta\text{LIQUIDITY}_{G,t+1} \\ &+ \beta_3 \Delta\text{LIQUIDITY}_{G,t-1} + \gamma_1 \Delta\text{LIQUIDITY}_{R,t} + \gamma_2 \Delta\text{LIQUIDITY}_{R,t+1} \\ &+ \gamma_3 \Delta\text{LIQUIDITY}_{R,t-1} + \delta_1 \text{RETURN}_{G,t} + \delta_2 \text{RETURN}_{G,t+1} \\ &+ \delta_3 \text{RETURN}_{G,t-1} + \delta_4 \Delta\text{VOLATILITY}_{E,t} + \varepsilon_{E,t},\end{aligned}$$

where $\text{LIQUIDITY}_{R,t}$ (i.e., regional liquidity) is the regional liquidity index computed on day t using an equal-weighted average of each corresponding liquidity measure for all firms trading on an exchange located in the same MSCI region as exchange E. All other variables are the same as defined above. Similar to

[22] Jain (2003) shows that larger, more developed markets tend to have lower relative tick sizes (absolute tick size divided by price) than smaller, less developed markets. One plausible explanation for our size and developed versus emerging market results is that relatively more binding tick sizes on smaller, emerging markets forces liquidity spillovers to be channeled through depths.

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regression (2), where we distinguish industry from exchange effects, regression (4) allows us to differentiate regional from global commonality influences.

In Table 9, we apply regression model (4) in order to measure any regional effects on commonality. Similar to our analysis of clusters of firms (by industry) on exchange-level commonality in Table 6, we examine clusters of exchanges (by MSCI region) on global commonality in Table 9. We report separate global and regional coefficients for all world exchanges, developed markets, and emerging markets. For the global (regional) spread results in Panel A of Table 9, our average contemporaneous coefficient is 0.1231 (0.1142) and our median coefficient is 0.1135 (0.0475). The regional contemporaneous coefficients are smaller and less significant than their global counterparts. The regional SUM coefficient is 0.0540 with a p-value of 0.243, while the global SUM coefficient is 0.1852 with a p-value of 0.001. For all exchanges combined, regional commonality plays a smaller (though still significant) role than global commonality.

TABLE 9

Global and Regional Commonality

Exchange-by-exchange (47) time-series regressions of liquidity measures are estimated using regression (4):

$$(4)\quad \Delta\text{LIQUIDITY}_{E,t} = \alpha + \beta_1 \Delta\text{LIQUIDITY}_{G,t} + \beta_2 \Delta\text{LIQUIDITY}_{G,t+1} + \beta_3 \Delta\text{LIQUIDITY}_{G,t-1} + \gamma_1 \Delta\text{LIQUIDITY}_{R,t} + \gamma_2 \Delta\text{LIQUIDITY}_{R,t+1} + \gamma_3 \Delta\text{LIQUIDITY}_{R,t-1} + \delta_1 \text{RETURN}_{G,t} + \delta_2 \text{RETURN}_{G,t+1} + \delta_3 \text{RETURN}_{G,t-1} + \delta_4 \Delta\text{VOLATILITY}_{E,t} + \varepsilon_{E,t}.$$

$\text{LIQUIDITY}_{E,t}$ is the exchange-level average relative effective spread (Panel A of Table 9) and total depth in value (Panel B) of exchange E on day t. $\text{LIQUIDITY}_{G,t}$ is the global liquidity index, and $\text{RETURN}_{G,t}$ is the global return computed on day t using an equal-weighted average of each corresponding liquidity measure and return, respectively, for all firms, except those firms trading on exchange E. $\text{LIQUIDITY}_{R,t}$ is the regional liquidity index computed on day t using an equal-weighted average of each corresponding liquidity measure for all firms trading on an exchange located in the same region as exchange E. $\text{VOLATILITY}_{E,t}$ is the return volatility for firms trading on exchange E on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. We present the average and median coefficient estimate of the exchange-level liquidity beta β_1, along with the percentage of firms for which β_1 is positive and significant at the 5% confidence level (t-statistic > 1.645), positive and not significant at the 5% confidence level, negative and not significant at the 5% confidence level, and negative and significant at the 5% confidence level, respectively. We report in the last two columns the median of the sum of the contemporaneous, lead, and lag coefficient estimates ($\text{SUM}_G = \beta_1 + \beta_2 + \beta_3$ and $\text{SUM}_R = \gamma_1 + \gamma_2 + \gamma_3$), and the average- and median-adjusted R^2s. Here, *, **, and *** indicate that the hypotheses median (SUM_G) = 0 and median (SUM_R) = 0 are rejected by a sign test at the 10%, 5%, and 1% confidence levels, respectively.

Exchange Portfolios		Avg. Coeff.	Median Coeff.	% of Firms with >0 Coeff. Signif. 5% Level	% of Firms with >0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Not Signif. 5% Level	% of Firms with <0 Coeff. Signif. 5% Level	Median SUM Coeff.	Avg. Adj. R^2	Median Adj. R^2
Panel A. Spread										
World (all exchanges)	β_1	0.1231	0.1135	25.53%	59.57%	10.64%	4.26%	0.1852***	0.046	0.037
	γ_1	0.1142	0.0475	23.40%	46.81%	25.53%	4.26%	0.0540		
All developed markets	β_1	0.1553	0.1553	33.33%	51.85%	11.11%	3.70%	0.2327*	0.047	0.037
	γ_1	0.1934	0.1873	33.33%	48.15%	18.52%	0.00%	0.1837***		
All emerging markets	β_1	0.0797	0.1012	15.00%	70.00%	10.00%	5.00%	0.1844**	0.045	0.038
	γ_1	0.0073	0.0003	10.00%	45.00%	35.00%	10.00%	–0.0131		
Panel B. Depth										
World (all exchanges)	β_1	0.0479	0.0344	13.33%	53.33%	31.11%	2.22%	0.0725**	0.061	0.027
	γ_1	0.0751	0.0398	26.67%	46.67%	24.44%	2.22%	0.0083		
All developed markets	β_1	0.0398	0.0248	12.00%	52.00%	36.00%	0.00%	0.0908	0.057	0.027
	γ_1	0.1234	0.0546	32.00%	48.00%	20.00%	0.00%	0.0397*		
All emerging markets	β_1	0.0580	0.0482	15.00%	55.00%	25.00%	5.00%	0.0675	0.065	0.029
	γ_1	0.0147	0.0035	20.00%	45.00%	30.00%	5.00%	–0.0113		

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We find quite different results, however, when we compare the developed market mix of regional versus global commonality to the emerging market mix. The regional component in developed markets is larger than and equally significant as the global component. In contrast, we find only weak evidence for regional commonality in spreads for the emerging markets.

In Panel B of Table 9, we analyze the separate impacts of global and regional liquidity on depth commonality. For global (regional) depth across all exchanges, we find an average contemporaneous coefficient of 0.0479 (0.0751) and a median coefficient of 0.0344 (0.0398). The regional contemporaneous coefficients are larger and more significant than their global counterparts, although this relation does not hold for the SUM coefficients. Turning to the developed-versus-emerging-market coefficients, we find a similar pattern to the spread results in Panel A.

Overall, these results demonstrate that a significant source of commonality in liquidity among exchanges is attributable to regional effects. This regional effect, while significant for spreads and depths across developed and emerging markets, does not fully account for global commonality. That is, there is a separate and distinct source of commonality in liquidity that spills over from exchanges outside of one's MSCI region.

4. Global versus Local Commonality

In this section, we examine the relative impact of the local and global components of commonality on the liquidity of individual firms. We perform firm-by-firm time-series regressions as follows:

$$
\begin{aligned}
(5)\ \Delta\text{LIQUIDITY}_{F,t} \;=\; & \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} \\
& + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} + \gamma_1 \Delta\text{LIQUIDITY}_{G,t} + \gamma_2 \Delta\text{LIQUIDITY}_{G,t+1} \\
& + \gamma_3 \Delta\text{LIQUIDITY}_{G,t-1} + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1} \\
& + \delta_3 \text{RETURN}_{E,t-1} + \delta_4 \Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t},
\end{aligned}
$$

where all variables are the same as defined above. We orthogonalize all independent variables using the modified Gram-Schmidt procedure as implemented in Stata (Golub and Van Loan (1996)). We present the average R^2 values when the γ coefficients are set to 0 (first column), when the β coefficients are set to 0 (second column), and when the model is unconstrained (third column). We report in the last three columns the proportion of R^2 contributed by i) local commonality, ii) global commonality, and iii) the control variables. When presented by market type (i.e., developed vs. emerging), the levels and proportions of R^2 are first averaged across firms at the exchange level and then aggregated across exchanges. When presented by firm size quintiles, the levels and proportions of R^2 are averaged across all firms in same quintile.

In Panel A of Table 10, we find average R^2s of 0.0584, 0.0392, and 0.0702 for the local only, global only, and combined local and global spread commonality regressions across all stock exchanges, respectively. The local exchange explains 38.32% of the individual firm's bid-ask spread commonality, the global factor explains 19.09%, and the control variables explain the remaining 42.59%. These

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findings mean that roughly 19% of an individual firm's bid-ask spread commonality is due to a global source outside the local exchange. We find similar results for both developed markets and emerging markets. For firms listed in developed markets, 34.10% (19.99%) of their commonality in spreads is caused by local (global) sources. For firms listed in emerging markets, 44.02% (17.88%) of their commonality in spreads is caused by local (global) sources. The higher local commonality proportions for emerging markets suggest that firms listed on these exchanges are relatively more susceptible to local liquidity conditions.[23]

TABLE 10

Local versus Global Commonality

Firm-by-firm (9,427) time-series regressions of liquidity measures are estimated using regression (5):

$$\begin{aligned}(5)\qquad \Delta\text{LIQUIDITY}_{F,t} &= \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} \\ &\quad + \gamma_1 \Delta\text{LIQUIDITY}_{G,t} + \gamma_2 \Delta\text{LIQUIDITY}_{G,t+1} + \gamma_3 \Delta\text{LIQUIDITY}_{G,t-1} \\ &\quad + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1} + \delta_3 \text{RETURN}_{E,t-1} + \delta_4 \Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t}.\end{aligned}$$

$\text{LIQUIDITY}_{F,t}$ is the relative effective spread (Panel A of Table 10) and the total depth in value (Panel B) of firm F on day t. $\text{LIQUIDITY}_{E,t}$ is the exchange-level liquidity index, and $\text{RETURN}_{E,t}$ is the exchange-level return computed on day t using an equal-weighted average of each corresponding liquidity measure and return, respectively, for all firms trading on the same exchange. $\text{LIQUIDITY}_{G,t}$ is the global liquidity index computed on day t using an equal-weighted average of each corresponding liquidity measure for all firms. All aggregated measures are computed after removing the effect of the left-hand-side variable. $\text{VOLATILITY}_{F,t}$ is the return volatility for firm F on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. All independent variables have been orthogonalized using the modified Gram-Schmidt procedure implemented in Stata (Golub and Van Loan (1996)). We present the average R^2 when the γ coefficients are set to 0 (first column), when the β coefficients are set to 0 (second column), and when the model is unconstrained (third column). We report in the last three columns the proportion of R^2 contributed by i) local commonality, ii) global commonality, and iii) the control variables. When presented by type of market, levels and proportions of R^2 are first averaged across firms at the exchange level and then aggregated across exchanges. When presented by firm size quintiles, levels and proportions of R^2 are averaged across all firms in same quintile. Quintiles are formed globally across all sample firms.

	Average R^2			Proportion of R^2		
Firm Portfolios	Local Commonality Only	Global Commonality Only	Local and Global Commonality	Contributed by Local Commonality	Contributed by Global Commonality	Contributed by Control Variables
Panel A. Spread						
World (all exchanges)	0.0584	0.0392	0.0702	38.32%	19.09%	42.59%
All developed markets	0.0470	0.0377	0.0585	34.10%	19.99%	45.91%
All emerging markets	0.0736	0.0413	0.0860	44.02%	17.88%	38.10%
Quintile 1 (smallest firms)	0.0539	0.0372	0.0662	37.61%	19.99%	42.40%
Quintile 2	0.0569	0.0410	0.0709	37.85%	19.90%	42.25%
Quintile 3	0.0594	0.0364	0.0708	40.84%	19.38%	39.78%
Quintile 4	0.0561	0.0387	0.0678	36.88%	20.27%	42.85%
Quintile 5 (largest firms)	0.0625	0.0403	0.0736	38.28%	18.69%	43.03%
Panel B. Depth						
World (all exchanges)	0.0791	0.0386	0.0910	39.87%	18.76%	41.38%
All developed markets	0.0530	0.0346	0.0650	35.75%	21.08%	43.17%
All emerging markets	0.1118	0.0437	0.1235	45.01%	15.85%	39.14%
Quintile 1 (smallest firms)	0.0667	0.0392	0.0809	36.92%	21.65%	41.44%
Quintile 2	0.0730	0.0389	0.0850	37.72%	21.00%	41.28%
Quintile 3	0.0760	0.0410	0.0889	36.95%	20.85%	42.20%
Quintile 4	0.0815	0.0364	0.0914	40.69%	16.94%	42.37%
Quintile 5 (largest firms)	0.0898	0.0346	0.0991	46.64%	15.18%	38.18%

[23]We find considerable variation across exchanges in the relative contributions of global versus local sources of spread commonality. For example, six exchanges have more than 30% of their R^2s attributable to global sources of commonality (Frankfurt Stock Exchange, Swiss Stock Exchange, Budapest Stock Exchange, Johannesburg Stock Exchange, Santiago Stock Exchange, and Mexican Stock Exchange), while 11 exchanges have less than 10% of their R^2s attributable to global sources of commonality (Virt-X, American Stock Exchange, Shanghai Stock Exchange, Shenzhen Stock Exchange, Jakarta Stock Exchange, Bombay Stock Exchange, National Stock Exchange of India, KOSDAQ, Korea Exchange, Taiwan Stock Exchange, and Istanbul Stock Exchange).

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We present the same figures across size quintiles formed globally for all sample firms. The results show relatively stable relations across the various size categories. For the globally formed quintiles, for example, the lowest global commonality contribution to R^2 is 18.69% (Quintile 5) and the highest is 20.27% (Quintile 4).[24]

In Panel B of Table 10, we find average adjusted R^2s of 0.0791, 0.0386, and 0.0910 for the local only, global only, and combined local and global depth commonality regressions, respectively, across all stock exchanges. The local exchange explains 39.87% of the commonality in the individual firm's depth, the global commonality factor explains 18.76%, and the control variables explain the remaining 41.38%. These findings show that, similar to the spread results, roughly 19% of the changes in an individual firm's depths are due to a commonality factor from outside the local exchange. We find similar results for both developed markets and emerging markets. For firms listed in developed markets, 35.75% (21.08%) of their changes in depths are due to local (global) sources. For firms listed in emerging markets, 45.01% (15.85%) of their depth commonality is due to local (global) sources. Again, similar to the spread results, the higher local commonality proportions for emerging markets suggest that firms listed on these exchanges are more susceptible to local liquidity conditions.[25]

The quintile portfolio results show relatively stable relations across the various size categories. However, unlike the spread results, there is a pattern of decreasing global commonality as we move from the smallest to the largest quintiles. For the globally formed quintiles, for example, the lowest global commonality contribution to R^2 is 15.18% (Quintile 5) and the highest is 21.65% (Quintile 1).

Overall, these results represent the first empirical evidence on the relative contributions of the local and global markets to commonality in liquidity. We find that global liquidity represents a significant component (i.e., roughly 19%) of the individual firm's liquidity.

Next, we extend this analysis by including industry and regional components to our local and global commonality. We estimate time-series regressions as follows:

$$
\begin{aligned}
(6)\ \Delta\text{LIQUIDITY}_{F,t} = {} & \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} \\
& + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} + \gamma_1 \Delta\text{LIQUIDITY}_{\text{EI},t} \\
& + \gamma_2 \Delta\text{LIQUIDITY}_{\text{EI},t+1} + \gamma_3 \Delta\text{LIQUIDITY}_{\text{EI},t-1} \\
& + \phi_1 \Delta\text{LIQUIDITY}_{R,t} + \phi_2 \Delta\text{LIQUIDITY}_{R,t+1}
\end{aligned}
$$

[24] Similar to our Table 5 results, we also form portfolio quintiles on an exchange-by-exchange basis (i.e., quintiles are first formed separately within each exchange and then combined, pooling all firms in the same quintile across the exchanges). The results from this alternative method are comparable to those reported in Table 10.

[25] We also find considerable variation across exchanges in the relative contributions of global versus local sources of depth commonality. For example, three exchanges have more than 30% of their R^2s attributable to global sources of commonality (Helsinki Stock Exchange, Frankfurt Stock Exchange, and Johannesburg Stock Exchange), while five exchanges have less than 10% of their R^2s attributable to global sources of commonality (Spanish Continuous Market, Shenzhen Stock Exchange, Jakarta Stock Exchange, Bursa Malaysia, and Istanbul Stock Exchange).

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$$+ \phi_3 \Delta \text{LIQUIDITY}_{R,t-1} + \eta_1 \Delta \text{LIQUIDITY}_{G,t} + \eta_2 \Delta \text{LIQUIDITY}_{G,t+1}$$
$$+ \eta_3 \Delta \text{LIQUIDITY}_{G,t-1} + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1}$$
$$+ \delta_3 \text{RETURN}_{E,t-1} + \delta_4 \Delta \text{VOLATILITY}_{F,t} + \varepsilon_{F,t},$$

where all variables are defined the same as above. Our independent variables have been orthogonalized using the modified Gram-Schmidt procedure implemented in Stata (Golub and Van Loan (1996)). We present the average R^2 when the β coefficients are set to 0 (all except local commonality, first column), when the γ coefficients are set to 0 (second column), when the ϕ coefficients are set to 0 (third column), when the η coefficients are set to 0 (fourth column), and when the model is unconstrained (fifth column). We report in the last five columns the proportions of R^2 contributed by i) local commonality, ii) industry commonality, iii) regional commonality, iv) global commonality, and v) the control variables. The levels and proportions of R^2 values are first averaged across firms at the exchange level and then aggregated across exchanges.

We show in Panel A of Table 11 that local and industry commonality contribute 28.75% and 12.49%, respectively, to the firm's comovement in bid-ask spreads. Regional and global commonality contribute 15.12% and 14.39%, respectively, to the firm's comovement in bid-ask spreads, and the control variables contribute the remaining 29.25%. We find that local, industry, regional, and global sources of commonality explain significant amounts of spread variations for both the developed and emerging markets. The main difference in proportional R^2s between developed and emerging markets is the relatively larger local source of spread commonality for the emerging markets (i.e., 34.52% vs. 24.48% for the local component in emerging vs. developed markets).

In Panel B of Table 11, we find that local and industry commonality contribute 30.12% and 16.68%, respectively, to the firm's comovement in depths. Regional and global commonality contribute 13.63% and 12.15%, respectively, and the control variables contribute the remaining 27.43%. Similar to the spread results in Panel A, we find that local, industry, regional, and global sources of commonality explain significant amounts of depth variations for both the developed and emerging markets. The main difference between developed and emerging markets is the relatively larger local source of depth commonality for the emerging markets (i.e., 36.08% vs. 25.35% for the local component in emerging vs. developed markets).

The combined results in Table 11 clearly demonstrate that commonality in liquidity has a number of sources: local, industry, regional, and global. The local source plays the dominant role for both spreads and depths. But even after accounting for local, industry, and regional sources of commonality, we find that the global component explains roughly 10% to 15% of the individual firms' commonality in liquidity.

C. Determinants of Commonality in Liquidity

In the third section of our analysis, we investigate the impact of macroeconomic news announcements on exchange-level and global commonality. We begin our macroeconomic analysis by collecting 23,445 macroeconomic announcements

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TABLE 11

Local versus Industry versus Regional versus Global Commonality

Firm-by-firm (9,427) time-series regressions of liquidity measures are estimated using regression (6):

$$
\begin{aligned}
(6)\qquad \Delta\text{LIQUIDITY}_{F,t} \;=\; & \alpha + \beta_1 \Delta\text{LIQUIDITY}_{E,t} + \beta_2 \Delta\text{LIQUIDITY}_{E,t+1} + \beta_3 \Delta\text{LIQUIDITY}_{E,t-1} + \gamma_1 \Delta\text{LIQUIDITY}_{\text{EI},t} + \gamma_2 \Delta\text{LIQUIDITY}_{\text{EI},t+1} + \gamma_3 \Delta\text{LIQUIDITY}_{\text{EI},t-1} \\
& + \phi_1 \Delta\text{LIQUIDITY}_{R,t} + \phi_2 \Delta\text{LIQUIDITY}_{R,t+1} + \phi_3 \Delta\text{LIQUIDITY}_{R,t-1} + \eta_1 \Delta\text{LIQUIDITY}_{G,t} + \eta_2 \Delta\text{LIQUIDITY}_{G,t+1} + \eta_3 \Delta\text{LIQUIDITY}_{G,t-1} \\
& + \delta_1 \text{RETURN}_{E,t} + \delta_2 \text{RETURN}_{E,t+1} + \delta_3 \text{RETURN}_{E,t-1} + \delta_4 \Delta\text{VOLATILITY}_{F,t} + \varepsilon_{F,t}.
\end{aligned}
$$

$\text{LIQUIDITY}_{F,t}$ is the relative effective spread (Panel A of Table 11) and the total depth in value (Panel B) of firm F on day t. $\text{LIQUIDITY}_{E,t}$ is the exchange-level liquidity index, and $\text{RETURN}_{E,t}$ is the exchange-level return computed on day t using an equal-weighted average of each corresponding liquidity measure and return, respectively, for all firms trading on the same exchange. $\text{LIQUIDITY}_{\text{EI},t}$ is the industry-level liquidity index computed on day t using an equal-weighted average of each corresponding liquidity measure for all firms in firm F's industry and exchange. $\text{LIQUIDITY}_{R,t}$ is the regional liquidity index computed on day t using an equal-weighted average of each corresponding liquidity measure for all firms trading on an exchange located in firm F's region. $\text{LIQUIDITY}_{G,t}$ is the global liquidity index computed on day t using an equal-weighted average of each corresponding liquidity measure for all firms. All aggregated measures are computed after removing the effect of the left-hand-side variable. $\text{VOLATILITY}_{F,t}$ is the return volatility for firm F on day t and is measured as the squared return for the day. The symbol Δ preceding a variable name denotes a proportional change in the variable across successive trading days. All independent variables have been orthogonalized using the modified Gram-Schmidt procedure implemented in Stata (Golub and Van Loan (1996)). We present the average R^2 when the β coefficients are set to 0 (first column), when the γ coefficients are set to 0 (second column), when the ϕ coefficients are set to 0 (third column), when the η coefficients are set to 0 (fourth column), and when the model is unconstrained (fifth column). We report in the last five columns the proportion of R^2 contributed by i) local commonality, ii) industry commonality, iii) regional commonality, iv) global commonality, and v) the control variables. Levels and proportions of R^2 are first averaged across firms at the exchange level and then aggregated across exchanges.

	Average R^2					Proportion of R^2				
	All except Local Commonality	All except Industry Commonality	All except Regional Commonality	All except Global Commonality	All Variables	Contributed by Local Commonality	Contributed by Industry Commonality	Contributed by Regional Commonality	Contributed by Global Commonality	Contributed by Control Variables
Panel A. Spread										
World (all exchanges)	0.0649	0.0847	0.0815	0.0831	0.0960	28.75%	12.49%	15.12%	14.39%	29.25%
All developed markets	0.0621	0.0725	0.0699	0.0696	0.0829	24.48%	12.69%	15.53%	15.96%	31.34%
All emerging markets	0.0687	0.1013	0.0972	0.1013	0.1137	34.52%	12.21%	14.57%	12.28%	26.42%
Panel B. Depth										
World (all exchanges)	0.0671	0.1028	0.1063	0.1088	0.1199	30.12%	16.68%	13.63%	12.15%	27.43%
All developed markets	0.0639	0.0761	0.0810	0.0838	0.0944	25.35%	18.61%	15.04%	13.14%	27.87%
All emerging markets	0.0711	0.1363	0.1379	0.1400	0.1518	36.08%	14.27%	11.87%	10.90%	26.87%

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on all 47 markets from Bloomberg. We eliminate all announcements that are unrelated to our four categories of interest. This filter leaves 6,026 news items specifically related to interest rate setting, consumer prices, unemployment, and GDP. We then aggregate these 6,026 separate news items into 3,020 macro news days, consisting of 502 interest rate setting announcements, 1,352 consumer price announcements, 656 unemployment announcements, and 510 GDP announcements.[26] We use a three-day event window (days −2 to 0) to measure the liquidity impact of the announcement in order to capture preannouncement portfolio rebalancing.[27] Chordia, Roll, and Subrahmanyam (2001) show that there are significant liquidity effects for unemployment and GDP announcements during days −1 and −2.

We employ Morck, Yeung, and Yu's (2000) "simple and direct measure of synchronicity," or comovement, since our main purpose is to measure the breadth of liquidity comovements during the event window. Following Morck et al. (2000), we measure the comovement of liquidity (as opposed to returns) at the exchange level for each trading day by first counting the number of firms with positive (negative) changes in their daily liquidity measure and then dividing the larger of these two numbers by their total. For each exchange, we average daily comovement percentages i) across all trading days (column 1 in Table 12), and ii) across only those trading days with domestic macroeconomic announcements (columns 2–5). In Table 12, we provide summary results for spread comovements in Panel A and depth comovements in Panel B. In Panels C and D, we report comparable results, except that we substitute U.S. macroeconomic announcements for domestic announcements. The purpose of this analysis is to measure the impact of U.S. macroeconomic news on domestic liquidity comovements.

The results in Panel A of Table 12 show that macroeconomic announcements significantly increase liquidity comovements in bid-ask spreads. The average comovement in spreads is 59.45% across all days and all exchanges. This percentage increases to 61.55% during interest rate setting announcements, 62.56% during consumer price announcements, 62.04% during unemployment announcements, and 62.70% during GDP announcements. We find similar results for both developed and emerging markets, with the exception of insignificant emerging market interest rate announcements.[28] Turning to Panel B, the average comovement in depths is 58.56% across all days and all exchanges. This percentage increases significantly to 61.55%, 61.77%, 61.52%, and 62.92% for interest rate, consumer price index, unemployment, and GDP announcements, respectively. Both developed and emerging markets show significant increases in all four announcement

[26]Developed market (emerging market) exchanges had averages of 13.9 (6.4), 24.8 (34.2), 18.0 (8.5), and 12.7 (8.4) announcements related to interest rates, consumer prices, unemployment, and GDP, respectively.

[27]For the most part, the timing (as opposed to content) of our announcements is known in advance. In the U.S., for example, the Federal Reserve and the Labor and Commerce Departments make regularly scheduled announcements of macroeconomic aggregates.

[28]We report statistical significance based on a one-tail, two-sample *t*-test for differences in means between the average of the comovement measure on macro event days and the unconditional sample average. The *t*-statistics are corrected for unequal variances whenever appropriate using the Satterthwaite approximation. We also report statistical significance based on the nonparametric Wilcoxon rank-sum test.

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TABLE 12

Commonality and Macroeconomic News

The columns show the liquidity comovement measure averaged across all trading days over the whole sample period and across event days on which four separate types of macroeconomic news are released: Macro 1 for interest rate setting such as the Federal Reserve Board Open Market Committee (FOMC) meetings in the U.S.; Macro 2 for the release of consumer price index (CPI); Macro 3 for the release of unemployment statistics; and Macro 4 for the release of gross national product (GDP). To capture the effects of the announcements, a three-day event window is used covering Day −2 to Day 0, where Day 0 is the day on which the macroeconomic release is made. Macroeconomic news releases are obtained from Bloomberg for each of the 38 countries over the sample period from October 1, 2002 to June 30, 2004. The comovement measure is computed at the exchange level (Panels A and B of Table 12) for each trading day for each exchange by first counting the number of firms with positive change in the daily liquidity measure and the number of firms with negative change in the daily liquidity measure, then dividing the larger of these two numbers by their total. For each exchange, the comovement measure is averaged across all trading days and across days with domestic Macro 1, Macro 2, Macro 3, and Macro 4 announcements. Summary results are reported in Panels A and B by type of market. The comovement measure is also computed at the cross-exchange level (Panels C and D) for each trading day by first counting the number of exchanges with positive change in the daily aggregate liquidity measure and the number of exchanges with negative change in the measure, and then dividing the larger of these two numbers by their total. For each grouping of exchanges in the developed and emerging markets, the comovement measure is averaged across all trading days and across days with the U.S. Macro 1, Macro 2, Macro 3, and Macro 4 announcements. Summary results are reported in Panels C and D by type of market. Here, *, **, and *** indicate that the test statistic is significant at the 10%, 5%, and 1% confidence levels, respectively, in a one-tail, two-sample *t*-test for difference in means between the average of the comovement measure on macro event days and the unconditional sample average. The *t*-statistics are corrected for unequal variances whenever appropriate using the Satterthwaite approximation. [a]indicates that the parametric *t*-test results are confirmed by the nonparametric Wilcoxon rank-sum test.

Exchange Portfolios	Whole Sample Period	Macro 1 (interest rate)	Macro 2 (CPI)	Macro 3 (unemployment)	Macro 4 (GDP)
Panel A. Exchange-Level Commonality in Spread and Domestic Macroeconomic News					
World (all exchanges)	59.45%	61.55%***[a]	62.56%***[a]	62.04%***[a]	62.70%***[a]
Developed markets	57.51%	61.76%***[a]	61.24%***[a]	61.34%***[a]	60.65%***[a]
Emerging markets	62.06%	61.03%	64.37%***[a]	63.56%***[a]	65.26%***[a]
Panel B. Exchange-Level Commonality in Depth and Domestic Macroeconomic News					
World (all exchanges)	58.56%	61.55%***[a]	61.77%***[a]	61.52%***[a]	62.92%***[a]
Developed markets	57.19%	61.45%***[a]	60.62%***[a]	61.28%***[a]	60.62%***[a]
Emerging markets	60.26%	61.80%***[a]	63.22%***[a]	61.98%***[a]	65.57%***[a]
Panel C. Global Commonality in Spread and U.S. Macroeconomic News					
World (all exchanges)	59.41%	59.27%	62.99%**[a]	62.67%***[a]	59.00%
Developed markets	61.48%	60.32%	64.85%**[a]	63.79%**[a]	61.48%
Emerging markets	61.59%	64.97%*	63.75%*[a]	63.83%**[a]	63.43%*[a]
Panel D. Global Commonality in Depth and U.S. Macroeconomic News					
World (all exchanges)	62.13%	60.13%	64.17%	65.13%**[a]	64.98%**[a]
Developed markets	63.90%	62.09%	65.83%	65.38%	65.80%
Emerging markets	64.74%	68.02%*[a]	66.44%	67.28%*[a]	65.18%

categories. Our Panel A and B findings clearly demonstrate the important link between changes in the domestic macroeconomic environment and secondary-market liquidity.

In Panels C and D of Table 12, we explore the possibility that macroeconomic news releases from one country (the U.S.) can affect liquidity comovements in other countries. During our sample period, we have 14 interest rate announcements and 21 consumer price index, unemployment, and GDP announcements each, yielding a total of 77 macroeconomic announcements. Our Panel C results show that U.S. announcements significantly impact spread comovements in developed markets for two of our four macroeconomic categories (consumer prices and unemployment); U.S. announcements for all four categories significantly impact spread comovements in emerging markets. Our Panel D results show that U.S. announcements have some significant impact on depth comovements, but this impact is considerably weaker than its bid-ask spread counterpart.

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The effect on developed market depth comovement is insignificant, and the effect on emerging market depth comovement is marginally significant in two of four categories (interest rates and unemployment). Overall, our Panel C and D results confirm that changes in the U.S. macroeconomic environment can spill over the border and increase liquidity comovements on non-U.S. exchanges.

IV. Summary and Conclusions

Previous empirical research finds a common exchange-level component that influences firm-level liquidity, both in terms of bid-ask spreads and depths. Although most of the empirical evidence is restricted to firms trading on a U.S. exchange (Chordia et al. (2000), Hasbrouck and Seppi (2001), Huberman and Halka (2001)), there is limited evidence of commonality on non-U.S. exchanges (Brockman and Chung (2002), Fabre and Frino (2004)). All previous studies that examine commonality in intraday spreads and depths are single-exchange studies.

Our study contributes to this literature in three primary ways. First, we conduct the first comprehensive investigation of commonality in liquidity using intraday spread and depth data from 47 stock exchanges. Second, we examine the impact of global versus local liquidity factors on spread and depth commonality. Third, we investigate the determinants of commonality. Given the size and scope of our Bloomberg database, we are able to analyze several aspects of commonality that previous, single-exchange studies could not address. These unresolved issues include the pervasiveness of spread and depth commonality, the cross-sectional variation in commonality among exchanges and regions, the existence of a global liquidity factor, and the impact of macroeconomic announcements on commonality.

Our empirical results confirm that exchange-level commonality is a widespread phenomenon across the globe. For most exchanges in our sample, the individual firm's bid-ask spreads are significantly influenced by changes in the aggregate market's bid-ask spreads. Similarly, changes in the individual firm's depths are significantly influenced by changes in exchange-level depths. Our cross-sectional results show that the emerging Asia stock exchanges exhibit exceptionally strong commonality in spreads and depths, while the stock exchanges of Latin American have little if any commonality at the exchange level.

After documenting the pervasive role of commonality *within* individual stock exchanges, we turn our attention to examining commonality *across* stock exchanges. We extend the empirical model of Chordia et al. (2000) in order to measure the impact of changes in intraday global liquidity on changes in aggregate exchange-level liquidity. Our findings represent the first empirical evidence for the existence of global commonality in spreads and depths. We find unambiguous support for the hypothesis that commonality in liquidity spills over the national border. Movements in aggregate bid-ask spreads and depths on an individual exchange are significantly influenced by movements in spreads and depths at both the global and regional level.

Next, we analyze the local (i.e., own exchange) versus global sources of commonality in liquidity. We orthogonalize all independent variables using the modified Gram-Schmidt procedure (Golub and Van Loan (1996)) and report the

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proportion of R^2 values contributed by local versus global sources of commonality. We show that local sources contribute 38.32% of the typical firm's bid-ask spread commonality, while global sources contribute 19.09%. We also show that local sources contribute 39.87% of the typical firm's depth-related commonality, while global sources contribute 18.76%. Overall, we find that the local source of commonality plays the dominant role for both spreads and depths. But even after accounting for local, industry, and regional sources of commonality, we find that the global component contributes from 10% to 15% of the typical firm's commonality in liquidity.

In the third section of our analysis, we examine the impact of 2,847 macroeconomic announcements on commonality in liquidity across our 47 exchanges and find a significant increase in commonality for both spreads and depths. We also investigate the impact of U.S. macroeconomic announcements on global commonality. Although weaker than domestic economy announcements, U.S. macroeconomic announcements significantly increase commonality levels across global markets.

In summary, our empirical findings verify that firm-level liquidity cannot be understood in isolation. Individual firm liquidity is determined in part by exchange, industry, regional, and global commonality components. Although our results provide some evidence on the causes of global liquidity comovements, additional research will be needed to refine our understanding of the channels through which liquidity changes in one region of the world affect liquidity changes in another.

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