Multimarket Trading, Price Spreads and Liquidity: Evidence from Cross-Listed Companies

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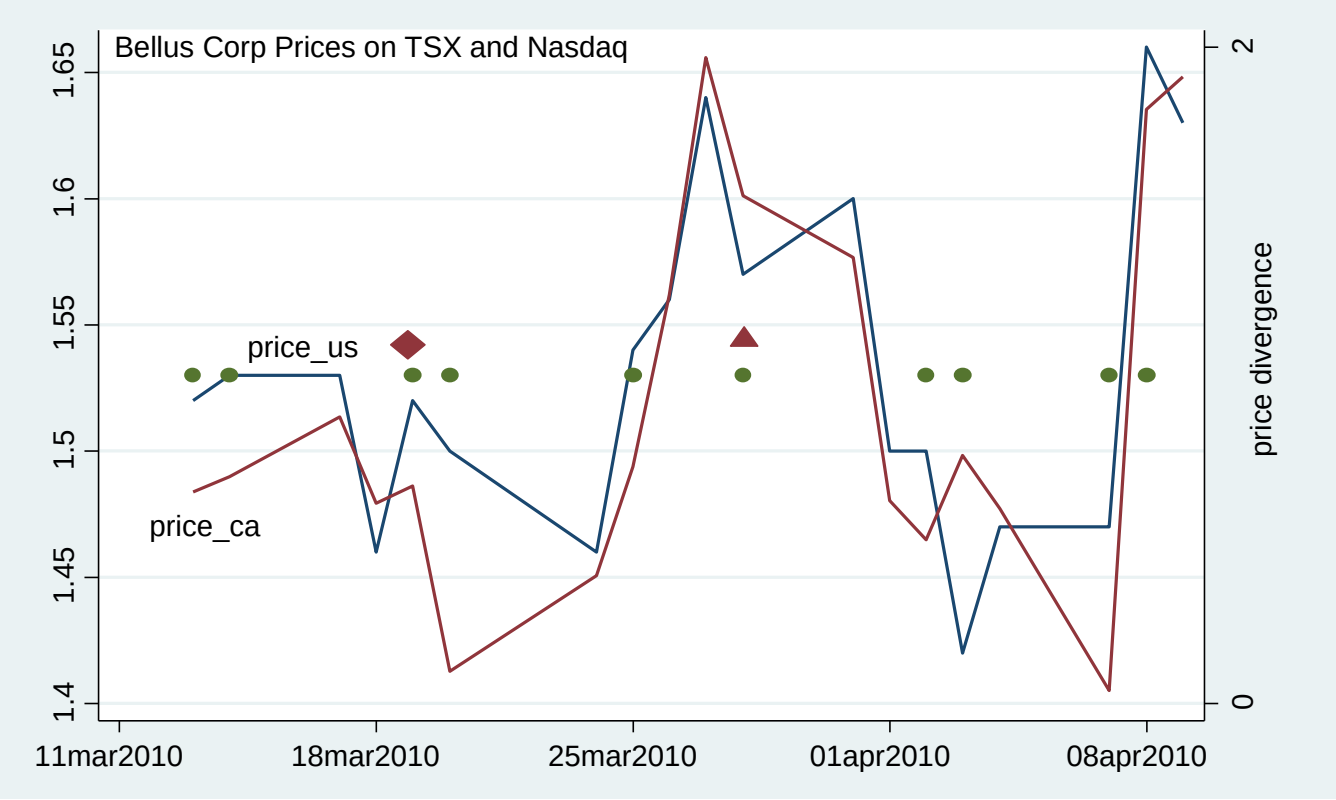
Motivation

- Deviations from parity for cross-listed stocks (Kaul and Mehrtra 2007, Gagnon and Karolyi 2010).



Motivation

- Research on arbitrage trading of institutional investors shows:
  - Long-short arbitrage plays minor role in correcting deviations.
  - One-sided trades correct most of the difference.
  - The trades were concentrated in the more liquid asset.

Motivation

- Financial institutions face agency frictions so could also be source of non-fundamental demand shocks, i.e. financial institutions do not always correct anomalies, can also cause them.
  - Market segmentation
  - Flash crash

Research Questions

- RQ1: What is the effect of liquidity on the cross-listed stock-pair price differential?
  - Is the effect of liquidity on price deviations positive or negative?

Searching for Explanations 1

- Asset pricing story: illiquidity depresses asset prices, and leads to higher expected returns.
  - Positive effect: High liquidity in the US market increases price of ADR (ordinary) and its premium.
  - Negative effect: High illiquidity in the home market depresses the price of the home share, and thus increases the premium.

Searching for Explanations 2

- Financial institutions story: Large changes in liquidity are due to institutional trading
  - Negative effect: higher US and home liquidity associated with lower ADR (ordinaries) premium.

Research Questions

- RQ2: Does liquidity affect the extent to which US and home market contribute to the price discovery.
  - liquidity improves the relative information content so increases the speed of short-term correction.

Research Questions

- RQ3: What is the effect of liquidity on the conditional probability that cross-listed pair prices converge? Is the effect different for:
  - ADR (ordinaries) with large changes in short interest.
  - Stocks with high holding costs (idiosyncratic volatility)

Results

- F1: Using 2001 decimalization & 2003 Dividend Tax Cut as a quasi-natural experiments, we find that higher ADR liquidity is associated with lower ADR premium.
- F2: We document a strong positive relationship between liquidity and price discovery.
  - Price discovery is dominated by the US market;
  - Positive effect of ADR liquidity on price discovery.
- F3: We document a liquidity effect on the price convergence. Institutional trading reduces deviations whereas large holding costs impede arbitrage.

Related Literature 1

- Differences in liquidity appear to explain part of the anomalies associated with price differentials for "closely related" assets.
  - Closed-end funds, Jain, Xia, and Wu (2004): premia on closed-end country funds correspond to differences in liquidity between the funds' host and home markets.
  - Amihud and Mendelson (1991), for U.S. Treasury notes and bills of identical maturities.
  - Boudoukh and Whitelaw (1993), for Japanese government bonds with a similar maturity and coupon.

Related Literature 2

- Gagnon and Karolyi (2003) document that ADR premium has higher co-movement with U.S. market index and lower co-movement with home market index. “excessive co-movements” are influenced by liquidity.
- Chan et al (2008) documents positive ADR liquidity effect on its premium.

Related Literature 3

- Cross listing (Karolyi, 2006)
  - Price effect: Jayaraman et al. (1993), Miller (1999), Foerster and Karolyi (1999, 2000)
  - Liquidity effect: Noronha et al (1996), Foerster & Karolyi (1998), Moulton & Wei (2010), Berkman & Nguyen (2010)
  - Price discovery process: Eun & Sabherwal (2003)

Data

- We use the complete list of foreign firms listed on US stock exchanges;
- Data sources:
  - CRSP, Datastream: daily prices and volume for US and home market;
  - TAQ: intraday US market prices.
  - Worldscope: Firm-level accounting data
  - Thomson Reuters for institutional holdings.

- Final sample: 650 stocks from 18 countries for period 2Jan1997 ~ 29Dec2012

Liquidity measures

- Illiquidity is unobservable, difficult to quantify….. even with actual market microstructure data.
- We use several illiquidity proxies:
  - Bid-ask spread over bid-ask midpoint;
  - Turnover: log daily volume over shares outstanding;
  - Amihud illiquidity: log of absolute daily return over dollar volume;
  - Number of zero return days over the number of trading days.

Summary statistics

	Mean	Median	Std Dev	5%	95%
Panel A: ADR (ordinaries) characteristics					
Premium/Discount (%)	2.36%	0.09%	0.1716	-4.00%	13.81%
SO(ADR)/SO(HOME)	17.55%	3.73%	0.3945	0.17%	99.41%
Volume(ADR)/Volume(HOME)	16.6354	1.0790	70.1644	0.0088	54.4319
Panel B: Liquidity measures	US market		Home market		
	Mean	Std Dev	Mean	Std Dev	T test
Spread	0.0237	0.0364	0.0233	0.0449	(0.024)**
Turnover	-6.4421	1.6255	-6.7788	1.4744	(0.000)***
Amihud	-17.2618	2.6917	-18.2194	3.1455	(0.000)***
Zeros	0.1570	0.1509	0.0959	0.1373	(0.000)***
Panel C: Firm characteristics					
Asset ($millions)	9,490	911	27,545	29	48,954
Sales ($millions)	4,857	623	11,815	3.5303	25,080
Debt to Asset	0.1697	0.1383	0.1437	0.0032	0.4567
Profitability	-0.0359	0.0110	0.1428	-0.3345	0.1047

In Short…

- On average, ADRs are traded at a premium of 2.36% percent (median premium is 0.09%)
- Although, ADR shares outstanding 17.55% (median 3.73%) of home market (underlying) equity similar volume in U.S. and home market, but huge variation.
- Bid-ask spread, Amihud's illiquidity and zero-return measures suggest higher liquidity for the home market.

Methodology – RQ1

- RQ1: What explains the variations in ADR premium?

$$Premium_{it} = a_i + \gamma_1 Liquidity_{it} + \gamma_2 FX\ premium_{it} + \gamma_3 \Delta Equity\ return_{it}^{Home} + \gamma_4 Firm\ factors_{it} + \gamma_5 Country\ factors_{it} + \varepsilon_{it}$$

  - Firm controls:
    - profitability, leverage, size, industry
    - holding costs (idiosyncratic risk), information asymmetry (analysts coverage, institutional ownership)
  - Country controls:
    - FX premium, changes in home market equity return, transaction cost, legal origin, shareholder rights, equity market development.

Methodology – RQ1

- RQ1: DiD approach

$$Premium_{it} = a + \theta_1 Treatment_i + \theta_2 Decimalization_t + \theta_3 Treatment \times Decimalization_{it} + Liquidity_{it}^{Home} + \gamma_2 FX\ premium_{it} + \gamma_3 \Delta Equity\ return_{it}^{Home} + \gamma_4 Firm\ factors_{it} + \gamma_5 Country\ factors_{it} + \varepsilon_{it}$$

- Decimalization as exogenous shock to liquidity.
- Based on change in ADR liquidity after decimalization, sort into terciles:
  - top tercile is treatment, bottom tercile is the control group.

Why DiD?

- Difference-in-difference approach:
  - excludes omitted trends that are correlated with stock liquidity and ADR premium in both the treatment and the control groups.
  - helps establish identification as tests are conducted around periods of policy changes that cause exogenous variation in the change in liquidity (the main independent variable).
  - with the inclusion of firm fixed effects we can control for unobserved differences between the treatment and the control groups.

Control and Treatment Groups

- We construct treatment and control groups using propensity score matching.
  - (1) calculating change in ADR liquidity from the pre-decimalization year (t-1) to the post-decimalization year.
  - (2) we sort the cross-listed firms into terciles based on the change in liquidity.
  - (3) estimate a probit model for top and bottom terciles:
    - dependent variable is equal to one if the firm-month belongs to the treatment group (top tercile) and zero otherwise and includes all control variables.
    - These variables are included to help satisfy the parallel trends assumption.
  - (4) use predicted probability in matching procedure

Methodology – RQ2

- RQ2: How does liquidity affect US market and home market contribution to price discovery?
  - Use ECM to estimate the speed of price convergence, α^H, α^{US}

$$\Delta p_{i,t}^{H} = \alpha_i^{H}\left(\beta_i^{H} p_{i,t-1}^{H} + \beta_i^{US} p_{i,t-1}^{US} + \beta_i^{Hindex} p_{i,t-1}^{Hindex} + \beta_i^{USindex} p_{i,t-1}^{USindex}\right) + \gamma_i \Delta p_{i,t-1}^{H} + \delta_i \Delta p_{i,t-1}^{US} + \theta_i \Delta p_{i,t-1}^{Hindex} + \vartheta_i \Delta p_{i,t-1}^{USindex} + a_i^{H}$$

$$\Delta p_{i,t}^{US} = \alpha_i^{US}\left(\beta_i^{H} p_{i,t-1}^{H} + \beta_i^{US} p_{i,t-1}^{US} + \beta_i^{Hindex} p_{i,t-1}^{Hindex} + \beta_i^{USindex} p_{i,t-1}^{USindex}\right) + \gamma_i \Delta p_{i,t-1}^{H} + \delta_i \Delta p_{i,t-1}^{US} + \theta_i \Delta p_{i,t-1}^{Hindex} + \vartheta_i \Delta p_{i,t-1}^{USindex} + a_i^{US}$$

Methodology – RQ2

- RQ2: How does liquidity affect US market and home market contribution to price discovery?
  - Pooled OLS regressions of correction coefficients on liquidity and control variables

$$|\alpha_i^H| = a_0 + a_1 Liquidity^{US} + a_2 FX\ vol + a_3 Equity\ vol + a_4 Firm\ factors + a_5 Country\ factors + \epsilon_1$$

$$|\alpha_i^{US}| = b_0 + b_1 Liquidity^{H} + b_2 FX\ vol + b_3 Equity\ vol + b_4 Firm\ factors + b_5 Country\ factors + \epsilon_2$$

Methodology – RQ3

- RQ3: What is the effect of liquidity on the duration of mispricing?
  - Cross-listed pair prices converge *when* the price difference is less than 1.5%
    - estimated round trip trading costs: e.g Grundy and Martin (2001), Mitchell and Pulvino (2002), Kaul and Mehrotra (2007).
  - Cox proportional hazard regression

$$h(t) = h_0(t)e^{(A_{it})}$$

$$A_{it} = a_i + \gamma_1 Liquidity_{it} + \gamma_2 FX\ vol_{it} + \gamma_3 Equity\ vol_{it} + \gamma_4 Firm\ factors_{it} + \gamma_5 Country\ factors_{it} + \varepsilon_{it}$$

Methodology – RQ3

- RQ3-1: What is the effect of liquidity on the price convergence for stocks with large changes in short interest?
- RQ3-2: What is the effect of liquidity on the price convergence for stocks with high holding costs?

Results – ADR premium and liquidity

ADR premium							
Liquidity measures							
Spread	Home	0.0024 (0.022)**					
	US	0.0027 (0.067)*					
Turnover	Home		0.0003 (0.328)				
	US		-0.0038(0.000)***				
Amihud	Home			-0.0020 (0.099)*			
	US			0.0005 (0.000)***			
Zeros	Home				0.0083 (0.383)		
	US				0.1478 (0.003)***		

Negative Liquidity-ADR Premium

- Baseline Model is consistent with the institutional story.
- An increase in the US market liquidity results in a decrease in the ADR (ordinaries) premium.
- The effect is large and economically significant.
  - one standard deviation increase in ADR bid-ask spread results in 2.64% increase in the ADR premium, which is large compared to the mean of 2.36% and the median of 0.09%.
  - Weaker effect for the home market liquidity, but some evidence that increase in the home market liquidity also decreases the ADR (ordinaries) premium.

Firm-level controls					
Profitability		0.0062	-0.0031	-0.0030	0.0005
Debt to Asset		-0.0028	-0.0117***	-0.0121***	-0.0095***
Log ADR size		0.0018***	0.0008**	0.0001	0.0007*
Idiosyncratic volatility	Home	-0.0038	0.0217***	0.0418***	0.0188***
	US	-0.0281	-0.0054	-0.0051	-0.0059
Analyst coverage		-0.0007***	-0.0006***	-0.0005***	-0.0004***
Institutional holdings		-0.0094***	-0.0108***	-0.0075***	-0.0089***
Country-level controls					
FX premium		-0.8268***	-0.4874***	-0.4641***	-0.5015***
ΔEquity market return		-0.0002	0.0001	-0.0015	0.0004
Stock market turnover		-0.0039**	-0.0054***	-0.0056***	-0.0024*
SH right		-0.0012*	-0.0017***	-0.0020***	-0.0016***
SMI		-0.0004	-0.0166**	-0.0123	-0.0060
Legal origin dummy		Yes	Yes	Yes	Yes
Financial crisis		0.0021*	0.0034***	0.0036***	0.0027**

The Rest of the RHS Variables

- The effect of liquidity on the premium remains significant when we control for information asymmetry and holding costs.
- The signs of these controls are as expected.
  - Increase in analyst coverage and institutional holdings (asymmetric information) decrease the ADR premium
  - Increase in the idiosyncratic volatility increases the ADR premium.
  - Foreign exchange premium and stock market development have a negative effect on the premium.

Results – ADR premium and liquidity

- DiD: decimalization as an exogenous liquidity shock

ADR premium	DiD, FE			
Treatment*Decimalization				
Spread	-0.1269***			
Turnover		0.0261***		
Amihud			-0.0123**	
Zeros				-0.0191***
Decimalization	0.1588***	-0.0285***	0.0045	0.0144***
Home liquidity	0.0172***	0.0036***	0.0042***	0.0522***

DiD Regression

- Increase in liquidity in the top tercile of the sample due to decimalization experience 12.69% lower ADR premium following decimalization than matched firms of similar characteristics but in the bottom tercile.

Results – VECM

Panel A: Cointegration rank test		
	Mean	Median
Rank, 95% significance	0.9549	1
Rank, 99% significance	0.8670	1

Panel B: Cointegration vector			
	Mean	Median	T test
US price	-0.9689	-0.9994	(0.478)
Home price	Normalize to 1		
US index	-0.0269	-0.0000	(0.305)
Home index	3.3156	-0.0000	(0.317)

Panel C: Error correction coefficients			
	Mean	Median	T test
US price	0.3595	0.2085	(0.000)
Home price	-0.4840	-0.4086	(0.000)
US index	25.0213	3.5726	(0.000)
Home index	-21.5030	-3.1372	(0.523)

Results – Price discovery and liquidity

Panel A: Price discovery and liquidity								
	(I)		(II)		(III)		(IV)	
	α^{H}	α^{US}	α^{H}	α^{US}	α^{H}	α^{US}	α^{H}	α^{US}
Liquidity measures								
Spread	0.3835***	1.1217						
	(0.007)	(0.396)						
Turnover			-0.091***	0.0132				
			(0.000)	(0.688)				
Amihud					-0.0610***	0.0056		
					(0.000)	(0.734)		
Zeros							-1.2516***	-0.1809
							(0.000)	(0.629)
Country dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	454	454	573	573	574	574	574	574
Adjusted R^2, %	15.06	5.62	14.15	6.41	14.81	6.40	16.36	6.44

Panel B: Price discovery and liquidity with firm and country-level controls								
Liquidity measures								
Spread	-15.9565***	-1.5683						
Turnover			0.1459***	0.0941***				
Amihud					-0.1540***	-0.0648**		
Zeros							-1.5928***	-1.2410**
Firm-level controls								
Profitability	-0.6151**	-0.8831***	-0.9796***	-1.0360***	-0.9862***	-1.0316***	-0.8922***	-1.0818***
Debt to Asset	-0.5149	0.0163	-0.5932	-0.1942	-0.5433	-0.2315	-0.6390	-0.1767
Log ADR size	0.0395	0.0047	0.1023***	0.0649*	-0.0511	0.0167	0.0590	0.0347
Idiosyncratic volatility	1.4953	1.5137	-0.0823	2.9221*	0.8833	3.9644**	-0.7762	1.4805
Analyst coverage	-0.0158	0.0064	-0.0194	-0.0022	-0.0193	0.0008	-0.0179	0.0033
Institutional holdings	0.3551**	0.2438	0.2579	0.0143	0.2410	0.1687	0.2723	0.1329
Country-level controls								
FX Volatility	-85.1059**	-27.7452	-86.1916***	-52.7180	-90.6102***	-51.0675	-77.6345**	-46.9133
Equity market volatility	-27.6760	-30.7912	-5.5817	-40.9530*	-1.7891	-39.9357*	-3.1764	-39.4092*
Stock market turnover	-0.0089***	-0.0035	-0.0129***	-0.0061**	-0.0127***	-0.0074*	-0.0102***	-0.0041
SH right	-0.0250	0.0488	0.0324	0.0946	0.0373	0.0783	0.0261	0.0956
SMI	0.5807	0.2315	0.8932	-0.1806	0.8297	-0.0602	0.8265	-0.0393

Results – duration and liquidity

		(a)	(b)	(c)	(d)
Liquidity					
Spread	Home	-1.1852***			
	US	-2.7707***			
Turnover	Home		0.0252***		
	US		0.0187**		
Amihud	Home			0.0013	
	US			-0.0136**	
Zeros	Home				0.0055
	US				-0.0290
Controls					
Financial crisis		0.0165	-0.0036	-0.0052	-0.0063
firm-level					
Profitability		0.2732*	0.2120*	0.1973*	0.2457**
Debt to Asset		-0.1889	-0.0925	-0.0616	-0.1008
Log ADR size		0.0070	0.0438***	0.0233	0.0459***
Idiosyncratic volatility	Home	-0.5313**	-0.4274*	-0.3346	-0.4283*
	US	0.3548	0.0463	-0.1560	0.0720
Analyst coverage		0.0084**	0.0079***	0.0095***	0.0087***
Institutional holdings		0.0383**	0.0167	0.0323	0.0313*
country-level					
FX Volatility	Home	-15.8138*	-11.7206	-14.5654*	-10.2818
Equity market volatility	Home	4.0542	-0.5973	1.1709	-0.3819
	US	-7.0911**	-6.0085**	-6.9007**	-6.5104**
Stock market turnover	Home	0.0256	-0.0057	0.0021	0.0246
SH right	Home	0.0137	0.0387	0.0471*	0.0382
SMI	Home	0.3085	0.4190*	0.4412*	0.4567*
Legal origin dummy	Home	Yes	Yes	Yes	Yes

Results – duration and liquidity

		(I)	(II)
Liquidity			
Spread	Home	0.0188 (0.395)	-0.0214 (0.194)
	US	-0.1522 (0.000)***	-0.0819 (0.000)***
Liquidity*Idiosyncratic volatility	Home	-0.3901 (0.161)	-0.3935 (0.009)***
	US	-0.0713 (0.031)**	-0.1050 (0.003)***
Liquidity*Institutional holdings	Home	0.0036 (0.840)	0.0523 (0.045)**
	US	0.0673 (0.003)***	0.0637 (0.035)**

Firm-level controls			
Profitability			0.2596**
			(0.022)
Debt to Asset			-0.2205*
			(0.064)
Log ADR size			-0.0003
			(0.982)
Idiosyncratic volatility	Home	-2.2111	-2.4488***
		(0.170)	(0.001)
	US	-0.2405	-0.3487
		(0.792)	(0.502)
Analyst coverage			-0.0032
			(0.357)
Institutional holdings		0.4885***	0.7267***
		(0.005)	(0.004)
Country-level controls			
FX Volatility			-14.1636
			(0.107)
Equity market volatility	Home		5.5601**
			(0.018)
	US		-8.7474***
			(0.008)
Stock market turnover	Home		0.0317
			(0.407)
Country and industry dummies			Yes
Financial crisis			0.0258
			(0.528)
Number of observations		342,366	273,798

Conclusions 1

- Negative premium effect of stock liquidity
- Liquidity effect on the contribution to price discovery of the U.S. market.
- Positive effect of liquidity on price convergence.
- Large changes in short interest and holding costs are important mechanisms through which liquidity affects price convergence.

Conclusions 2

- Small size for an ADR program in relation to its total amount outstanding may have large illiquidity effects.
- Large ADR program may cause the liquidity in the home market to dry up.
- What is the optimal size?