Financial Intermediaries and Contagion in Market Efficiency: The Case of ETFs

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ABFER 2022

Outline

Motivation

- The recent intermediary-based asset pricing literature (He and Krishnamurthy, 2013) emphasize
  - The key determinant of asset prices is the balance sheet capacity of financial intermediaries who are often marginal investors in many assets
  - Supporting empirical evidence: Adrian, Etula, and Muir (2014); He, Kelly, and Manela (2017)
  - Construct a proxy for the intermediary stochastic discount factor (SDF) that explains the cross-sectional variation in asset returns

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  - Construct a proxy for the intermediary stochastic discount factor (SDF) that explains the cross-sectional variation in asset returns
- One key identification challenge is an omitted variable problem:
  - The relationship between intermediary balance sheet capacity and asset prices is spurious, driven by macroeconomic factors or time-varying sentiment or risk aversion
  - Baron and Xiong (2017); Gomes, Grotteria, and Wachter (2019); Santos and Veronesi (2021)

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  - Test sharper prediction that intermediary constraints will have a larger impact on prices when intermediaries are more likely to be the "marginal" investor (Baron and Muir, 2020)
  - Pricing efficiency in ETFs is cleanly defined
  - Large size and fast growth of ETFs suggests understanding the determinants of ETF pricing (in)efficiency is important

Motivation (cont'd)

- Exchange traded funds (ETFs) have grown exponentially in both size and scope over the past decade

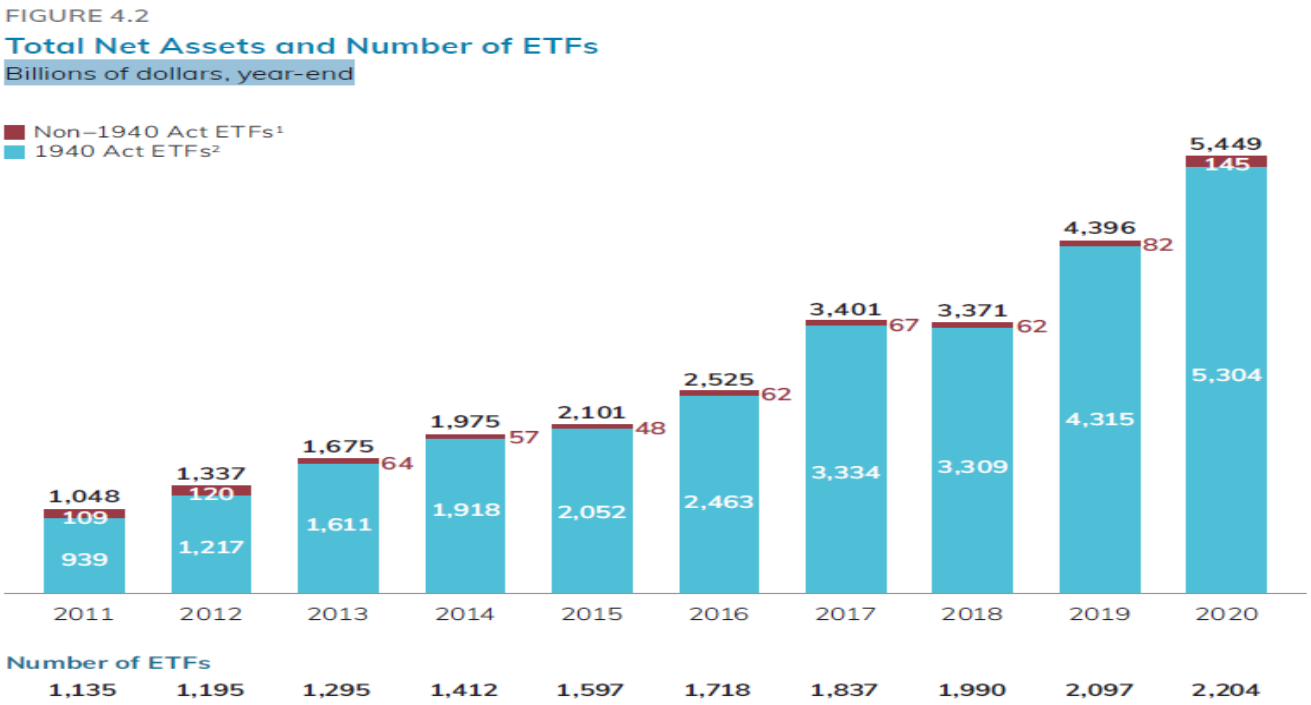

Figure: 2021 Investment Company Factbook

Institutional Background: ETF Creation/Redemption

- ETF shares are traded on the exchange intraday
  - Investors buy/sell ETF shares through brokers – and pay commissions on the trades
  - Shares are only redeemable from the fund itself in very large blocks

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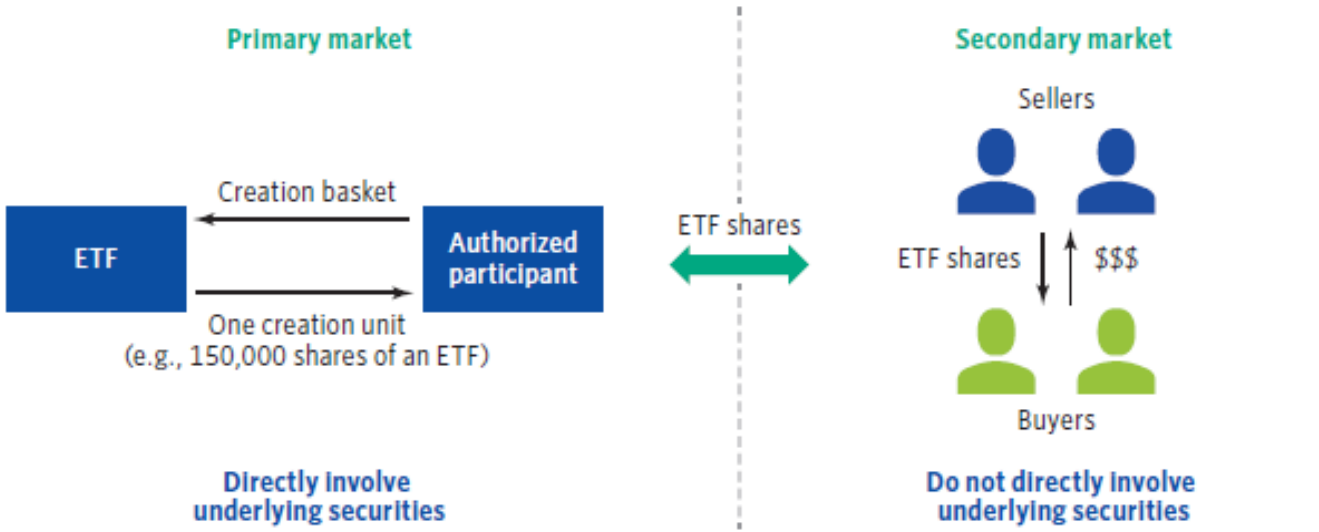
FIGURE 3.3
Creation of ETF Shares



Note: The creation basket represents a specific list of securities, cash, and/or other assets.

Institutional Background: ETF Arbitrage

- ETF price may differ from its NAV
  - LMM and APs can correct mispricing in the primary market by exchanging shares of ETFs with underlying basket securities
  - Hedge funds and other high-frequency traders can take advantage of mispricing by taking L/S positions in secondary markets

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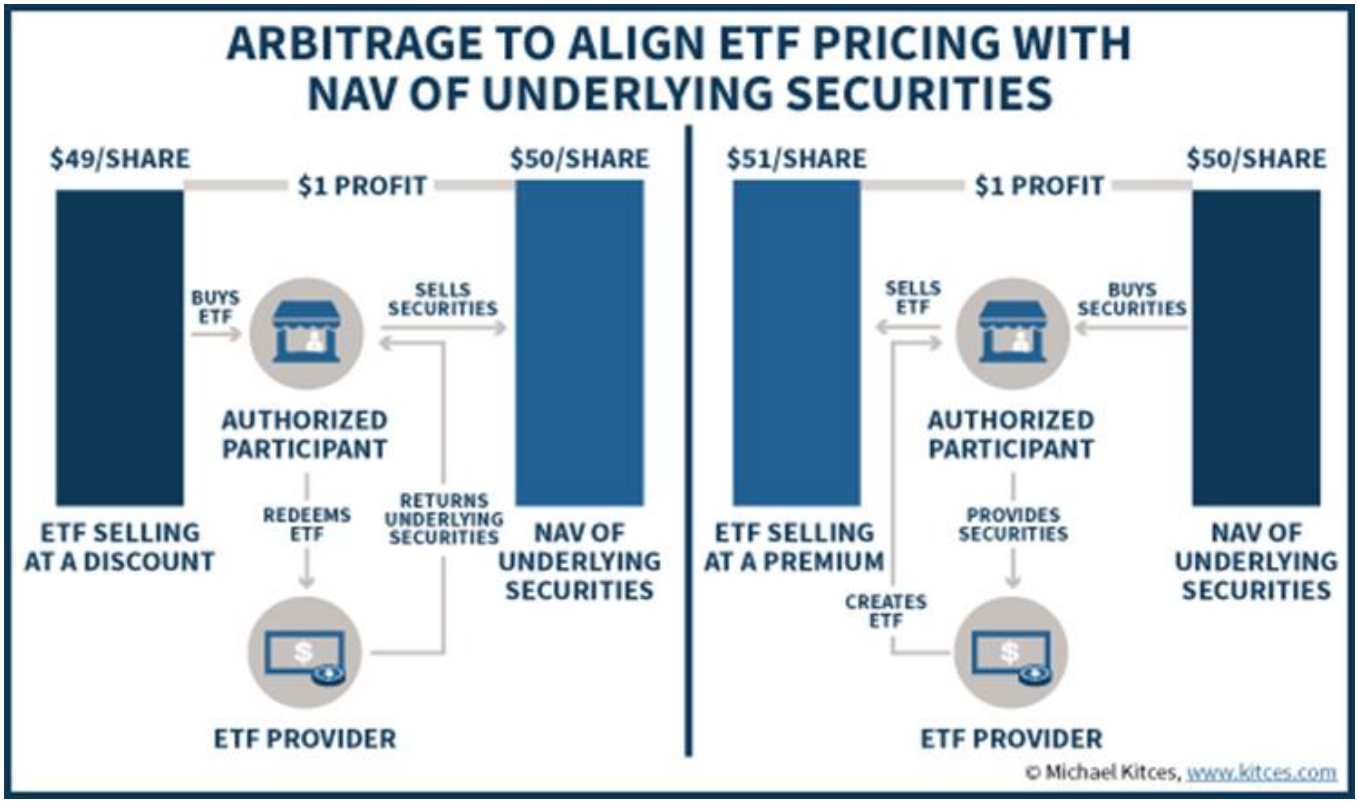

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- Importantly, this prediction will not hold if LMM is not subject to capital constraint
  - According to ETF Global, one LMM usually needs to simultaneously maintain the law of one price in dozens or even hundreds of ETFs
- Caveat: We only observe LMM while ETFs have other APs providing liquidity simultaneously
  - Other APs should only weaken the role of LMM, and bias us against finding any LMM-level comovement effect

Preview of the Results

- ETF mispricing is measured as $|Premium|$, defined as the absolute value of the percentage deviation of the ETF price from its net asset value (NAV)
- Further orthogonalize the $|Premium|$ with respect to non-LMM $|Premium|$, and use the residual $|Premium|$ in tests

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- We find a strong comovement in $|Premium|$ of ETFs sharing the same LMM
  - 1-STD increase in the average $|Premium|$ of ETFs managed by the same LMM leads to a 1.72 bps increase in the focal ETFs' $|Premium|$, equivalent to 7.5% of its STD
  - Annual dollar cost of \$90.64 million for investors who trade ETFs at inopportune times

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  - Annual dollar cost of \$90.64 million for investors who trade ETFs at inopportune times
- The LMM-level comovment effect is stronger for:
  - ETFs with higher return volatility, lower liquidity, and smaller market cap
  - ETFs whose underlying assets are on average more costly to arbitrage
  - When the LMM faces more severe capital constraints

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- We contribute to the growing literature on the impact of ETFs on financial markets
  - Non-fundamental demand shocks transmitted from the ETFs to their underlying securities affect the pricing of the latter
  - Petajisto (2017): significant deviation of ETF prices from its NAV, especially for ETFs holding illiquid securities
  - We focus on the comovement (instead of the level) of mispricing across ETFs

Outline

Data

- We get daily data for US listed ETFs from ETF Global from January 1, 2012 to December 31, 2020
  - It offers detailed ETF data including NAV, price, shares outstanding, bid/ask, trading volume, inception date, and LMM
  - We verify (and correct any data error) using data from CRSP securities and mutual fund data
  - The list of LMMs match with the LMM names provided by NYSE Arca
  - Final sample includes 3,848 ETFs with broad regional and asset class coverage

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- LLMs play a critical role in facilitating the functioning of the ETF ecosystem
  - One LMM, RBC Capital Markets, mentions that LMM *"fulfills other important roles in addition to providing liquidity and maintaining market equilibrium – they also help to ensure the market price of each ETF unit reflects the value of its underlying securities intraday"*

List of Lead Market Makers

LMM	#ETF	Size (billion USD)	Raw $\lvert Premium \rvert$	$\lvert Premium \rvert$
Goldman Sachs	280	634.5	20.56	-0.97
KCG	364	489.5	30.92	1.41
Virtu Financial	203	377.6	17.25	-0.43
Jane Street	209	316.3	33.99	1.75
Susquehanna	215	302.6	29.06	0.16
IMC Chicago	105	204.2	16.71	0.42
Cantor Fitzgerald	109	122.2	26.31	0.35
Latour Trading	25	97.1	5.08	-0.05
Pundion	23	74.2	22.24	2.4
Credit Suisse	38	63	21.48	-1.13
RBC Capital Markets	32	37.7	19.17	0.15
Citadel	22	32.6	14.8	-0.78
Deutsche Bank	19	17.3	19.11	-0.32
Flow Traders	10	12.9	26.15	0.73
Societe Generale	9	6.4	23.78	-2.81
Wolverine Trading	5	4.1	19.01	-0.21
CLP	3	1.4	48.38	0.77
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- Some LLMs in our sample are financial services companies (Goldman Sachs and Credit Suisse), some are independent market makers (Virtu Financials), and others are hedge funds (affiliated MM) (Citadel and Jane Street)

Measuring ETF Mispricing

- ETF mispricing is measured by ETF premium, defined as:

$$Premium = \frac{ETF\ Price - ETF\ NAV}{ETF\ NAV} \tag{1}$$

- We use $|Premium|$ because the deviation of ETF price from NAV (regardless of the direction) determines LMM's arbitrage profits

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- To make sure the comovement in ETF raw $|Premium|$ is not simply driven by aggregate funding constraints, we orthogonalize each ETF's raw $|Premium|$ w.r.t its non-LMM raw $|Premium|$

$$\text{raw } |Premium|_{i,t} = \beta_0 + \beta_1 \text{non-LMM raw } |Premium|_{i,t} + \epsilon_{i,t}, \tag{2}$$

- non-LMM raw $|Premium|_{i,t}$ is the average raw $|Premium|$ across all ETFs managed by LMMs that are different from that of the focal ETF i

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- We use the full sample to estimate Equation (2) and take the regression residual $\epsilon_{i,t}$ as the main variable of interest, $|Premium|_{i,t}$

Time Series Patterns

- Total AUM of ETFs managed by an average LMM increased from $106 billion to $226 billion from 2012 to 2020

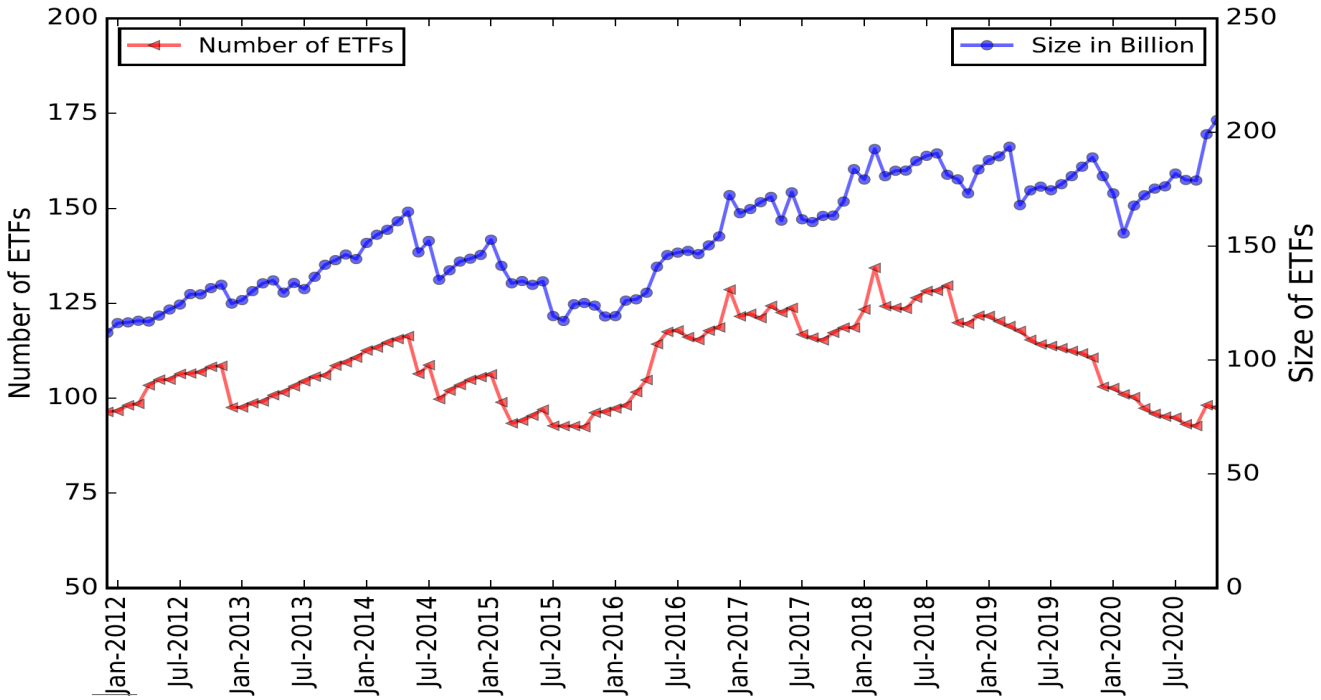

Figure: Number and total AUM of ETFs managed by an average LMM

- LMMs could face tightening capital constraints over time if their capital does not grow at the same pace

Time Series Patterns (cont'd)

- The average raw $|Premium|$ is highly correlated with VIX
- The average residual $|Premium|$ is flat, suggesting that it mostly captures the idiosyncratic component of ETF mispricing

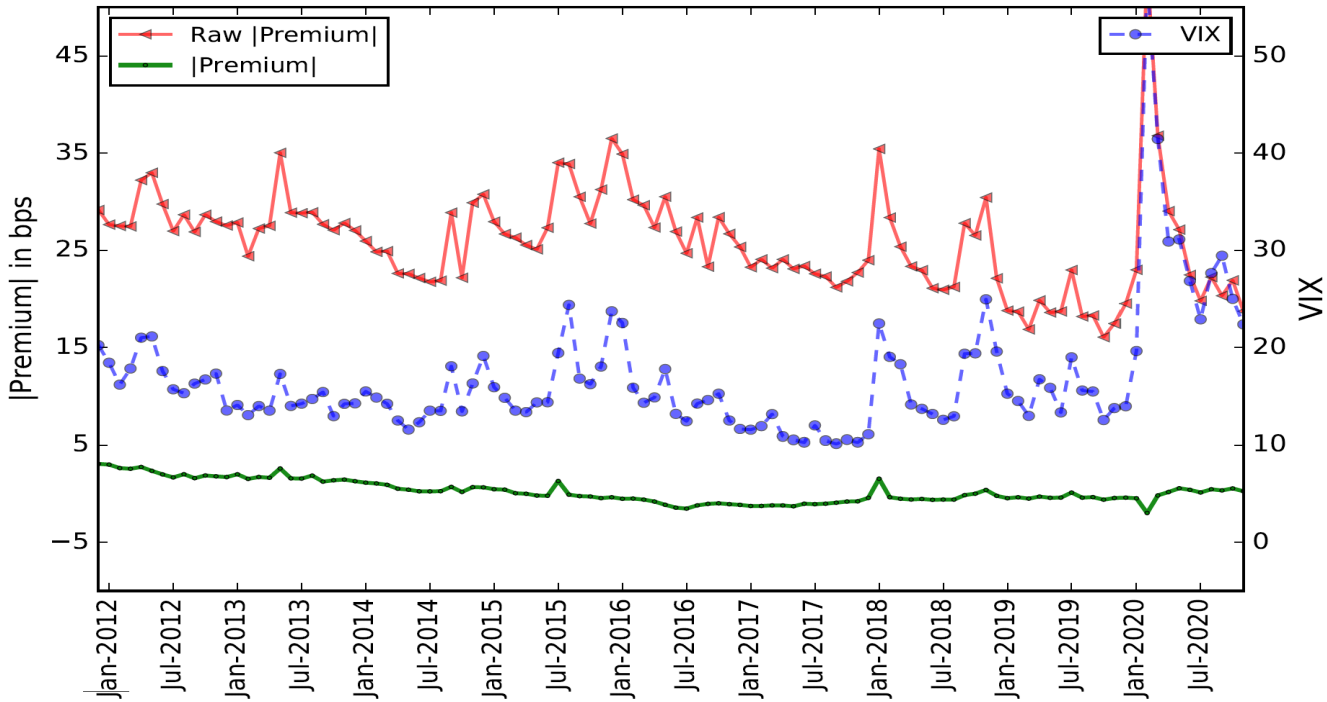

Figure: Average raw and residual $|Premium|$

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Baseline Regression

- We run panel regressions of each ETF's daily $|Premium|$ on the equal-weighted average $|Premium|$ of all ETFs sharing the same LMM (excluding focal ETF)

$$|Premium|_{i,j,t} = \beta_0 + \beta_1 \text{LMM } |Premium|_{i,t} + \beta_2 \text{non-LMM } |Premium|_{i,t} + \beta_3 X_{i,t} + \alpha_i + \gamma_{j,t} + \epsilon_{i,t}, \quad (3)$$

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- In the baseline, we also control for non-LMM $|Premium|_{i,t}$, which is the average $|Premium|$ of all ETFs served by an LMM that is different from that of the focal ETF
- $X_{i,t}$ is a set of control variables, including ETF size ($Log(Size)$), ETF turnover ($Turnover$), ETF bid-ask spread ($BidAsk$), and ETF return volatility (STD)

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- We predict the coeff. of interest, β_1, to be significantly positive
- We standardize all independent variables and double cluster the standard errors at ETF and Day level

Baseline Regression, result

Dep.Var = $\lvert Premium \rvert$				
	(1)	(2)	(3)	(4)
non-LMM $\lvert Premium \rvert$ (a)	-0.06			
	(-0.73)			
LMM $\lvert Premium \rvert$ (b)	2.123***	1.997***	1.684***	1.716***
	(21.37)	(20.87)	(18.64)	(18.89)
Log (Size)		-2.989***	0.872***	-3.321***
		(-9.99)	(8.89)	(-9.94)
STD		-0.364***	0.798***	1.991***
		(-4.04)	(7.73)	(12.14)
BidAsk		6.210***	2.701***	6.558***
		(25.22)	(18.92)	(25.70)
Turnover		0.326**	0.233***	0.404***
		(2.56)	(3.50)	(3.14)
Asset*Day FE	N	N	Y	Y
ETF FE	N	Y	N	Y
Observations	2,946,278	2,946,278	2,946,278	2,946,278
R-squared	0.008	0.036	0.038	0.059
(b)-(a)	2.184***			
F-stat.	(20.06)			

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- To show LMMs cause mispricing comovement, we conduct event studies around the days when ETFs change LMM
  - Anecdotal evidence suggests that change in LMM is usually because the LMM decides to retreat from market making due to high regulatory and other costs of operating
  - Change of LMM for an *individual* ETF should be relatively exogenous to the ETF's unobserved characteristics that drive mispricing comovement

Event Study Based on ETFs Switching LMM (cont'd)

- We identify 1,264 events where an ETF changed its LMM
- We choose a window of $[-120, 120]$ trading days, with day 0 as the date on which the ETF changed its LMM

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$$+\beta_3 LMM_{new} \ |Premium|_{i,t} + \beta_4 Post_t * LMM_{new} \ |Premium|_{i,t} + \beta_6 Post_t + \beta_7 X_{i,t} + \epsilon_{i,t},$$

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$$+\beta_3 LMM_{new}\ |Premium|_{i,t} + \beta_4 Post_t * LMM_{new}\ |Premium|_{i,t} + \beta_6 Post_t + \beta_7 X_{i,t} + \epsilon_{i,t},$$

- $LMM_{old}\ |Premium|_{i,t}$ ($LMM_{new}\ |Premium|_{i,t}$) is the average $|Premium|$ of ETFs managed by the old (new) LMM before (after) switching
- $Post_t$=1 for the days after an ETF changes its LMM

Event Study Based on ETFs Switching LMM (cont'd)

- We identify 1,264 events where an ETF changed its LMM
- We choose a window of $[-120, 120]$ trading days, with day 0 as the date on which the ETF changed its LMM

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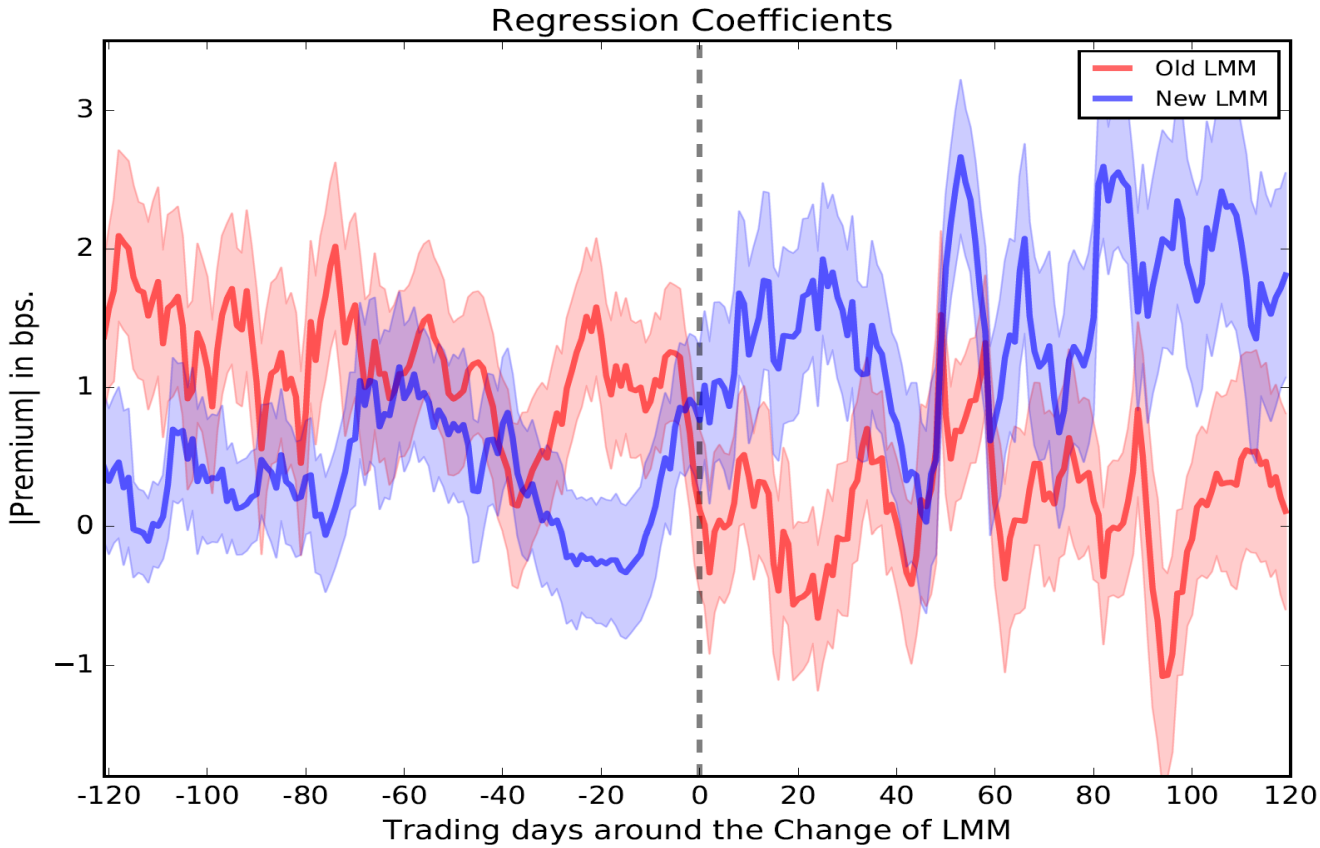
- $Post_t$=1 for the days after an ETF changes its LMM
- In some specifications, we include returns on Fama-French five factors and Fama-French 10 industries to control for correlated demand shocks to ETFs belonging to the same styles or sectors
- β_2 (β_4) should be significantly negative (positive)
- And β_3 should be insignificant

Event Study Based on ETFs Switching LMM (cont'd)

- After the change, an ETF's mispricing comoves less (more) with that of other ETFs served by the old (new) LMM



Event Study Based on ETFs Switching LMM, result

	Dep. Var. = |*Premium*|				
	(1)	(2)	(3)	(4)	(5)
LMM_Old |*Premium*|	1.167***	1.210***	1.176***	1.146***	1.146***
	(4.39)	(4.93)	(4.41)	(3.94)	(3.86)
Post*LMM_Old |*Premium*|	-0.932***	-0.967***	-0.951***	-0.997***	-0.994***
	(-3.72)	(-4.21)	(-4.37)	(-4.49)	(-4.50)
LMM_New |*Premium*|	0.268	0.242	0.226	0.225	0.222
	(1.42)	(1.34)	(1.28)	(1.25)	(1.23)
Post*LMM_New |*Premium*|	1.441***	1.567***	1.575***	1.510***	1.499***
	(2.94)	(2.94)	(2.93)	(3.09)	(3.06)
Post	0.424	0.774	0.477	0.534	0.552
	(1.14)	(1.18)	(0.62)	(0.72)	(0.76)
Log(Size)		1.520***	1.488***	1.485***	1.485***
		(4.40)	(4.21)	(4.18)	(4.18)
Std		0.449	0.443	0.452	0.453
		(1.60)	(1.63)	(1.62)	(1.62)
BidAsk		3.191***	3.190***	3.192***	3.193***
		(7.19)	(7.29)	(7.32)	(7.33)
Turnover		-0.436***	-0.437***	-0.440***	-0.441***
		(-3.49)	(-3.89)	(-3.85)	(-3.85)
Controls of Aggregate Funding Constraints			Y	Y	Y
FF 5 factors				Y	Y
FF 10 Industries					Y
Observations	189,471	189,432	189,432	189,432	189,432
R-squared	0.005	0.02	0.02	0.02	0.02

Interaction with ETF Characteristics

- Smaller ETFs and ETFs with higher return volatility and lower liquidity require more costly liquidity provision from its LMM to maintain price efficiency

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	Dep. Var. = $\lvert Premium \rvert$		
	(1)	(2)	(3)
LMM $\lvert Premium \rvert$	1.704***	1.682***	1.719***
	(18.68)	(18.84)	(18.91)
Log (Size)*LMM $\lvert Premium \rvert$	-0.283***		
	(-3.30)		
STD*LMM $\lvert Premium \rvert$		0.232***	
		(4.15)	
BidAsk*LMM $\lvert Premium \rvert$			0.284***
			(3.23)
Log (Size)	-3.315***	-3.325***	-3.335***
	(-9.94)	(-9.95)	(-10.02)
STD	1.994***	1.983***	1.993***
	(12.17)	(12.12)	(12.16)
BidAsk	6.551***	6.554***	6.528***
	(25.70)	(25.68)	(25.84)
Turnover	0.390***	0.404***	0.400***
	(3.03)	(3.14)	(3.13)
Asset*Time FE	Y	Y	Y
ETF FE	Y	Y	Y
Observations	2,946,278	2,946,278	2,946,278
R-squared	0.059	0.059	0.059

Interaction with Arbitrage Costs of ETFs' Constituents

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	Dep. Var.= $\lvert Premium \rvert$		
	(1)	(2)	(3)
LMM $\lvert Premium \rvert$	0.344***	0.344***	0.371***
	(5.18)	(5.19)	(5.31)
Spread CS	0.626***		
	(2.65)		
LMM $\lvert Premium \rvert$*Spread CS	0.143**		
	(2.49)		
Volatility		0.723***	
		(2.70)	
LMM $\lvert Premium \rvert$*Volatility		0.131**	
		(2.43)	
Supply			0.402
			(0.93)
LMM $\lvert Premium \rvert$*Supply			-0.254***
			(-2.68)
Log (Size)	-2.331***	-2.324***	-2.212***
	(-5.85)	(-5.85)	(-5.86)
STD	0.185	0.084	0.219
	(0.85)	(0.37)	(1.03)
BidAsk	5.226***	5.228***	5.234***
	(9.39)	(9.42)	(9.88)
Turnover	0.315	0.317	0.357*
	(1.49)	(1.53)	(1.68)
Time FE	Y	Y	Y
ETF FE	Y	Y	Y
Observations	844,539	844,539	809,313
R-squared	0.071	0.071	0.07

The role of LMM-specific capital constraints

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- *Log*(1/#*Active APs*): the log of one divided by the number of active APs, collected from SEC N-CEN filings
  - In addition to LMMs, APs also play an important role in maintaining the law of one price for ETFs

The role of LMM-specific capital constraints, result

Dep. Var.= $\lvert Premium \rvert$			
	(1)	(2)	(3)
LMM $\lvert Premium \rvert$	1.648***	1.841***	1.824***
	(18.20)	(18.70)	(11.82)
Creation	0.015		
	(0.75)		
Creation*LMM $\lvert Premium \rvert$	0.046**		
	(2.01)		
Log (Mktcap of ETFs)		0.158	
		(1.10)	
Log (Mktcap of ETFs)*LMM $\lvert Premium \rvert$		0.324***	
		(8.70)	
Log (1/#Active APs)			0.452
			(1.20)
Log (1/#Active APs)*LMM $\lvert Premium \rvert$			0.365***
			(2.88)
Log (Size)	-3.224***	-3.250***	-2.863***
	(-9.71)	(-9.72)	(-3.28)
STD	1.876***	1.877***	0.659**
	(9.96)	(9.99)	(2.46)
BidAsk	6.293***	6.282***	2.985***
	(25.31)	(25.31)	(7.45)
Turnover	0.434***	0.437***	0.561***
	(3.52)	(3.53)	(3.47)
Asset*Day FE	Y	Y	Y
ETF FE	Y	Y	Y
Observations	2,943,920	2,946,278	666,913
R-squared	0.059	0.06	0.114

ETF Mispricing during COVID-19 pandemic

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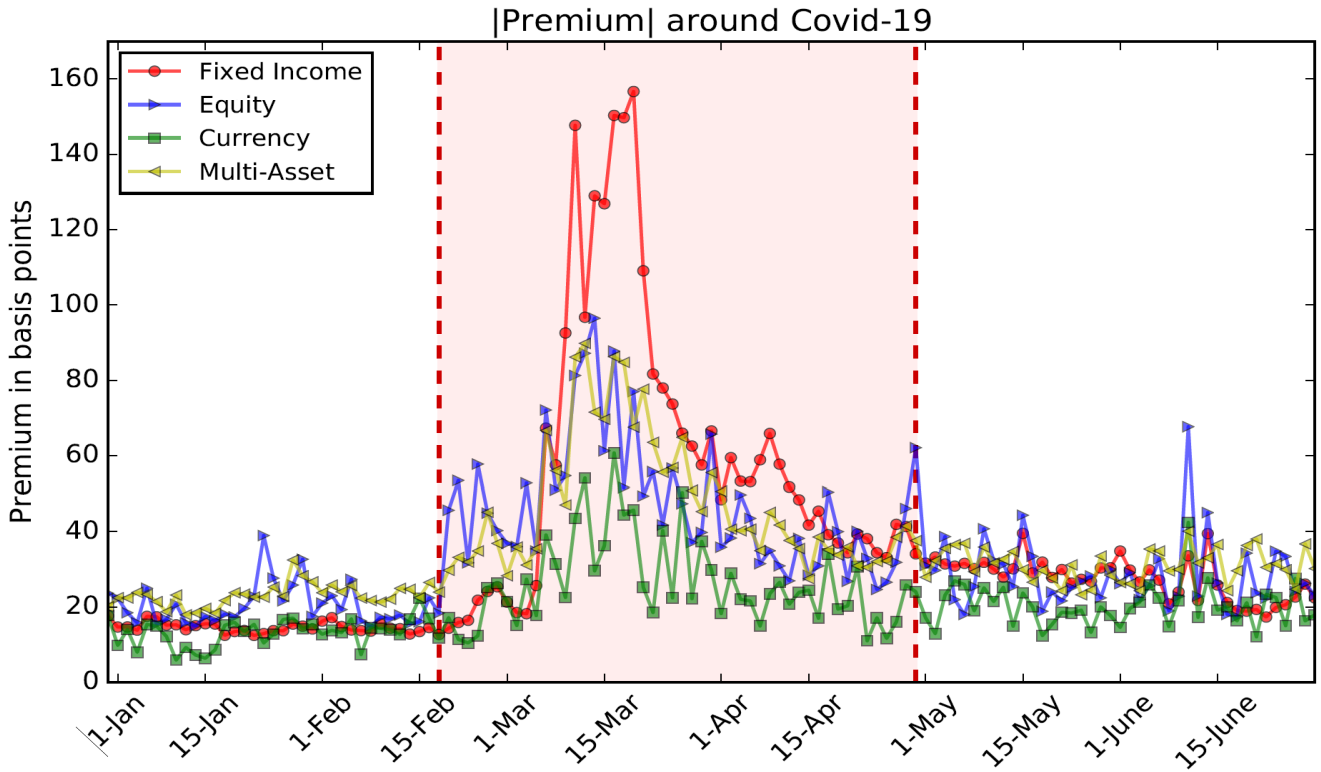

- Area shaded in red indicates the period when COVID-19 caused significant financial market turmoil, from February 20, 2020, to April 30, 2020 (Pastor and Vorsatz, 2020)

DiD Analysis of ETF premium during COVID-19 pandemic

- LMMs who need to manage a larger fraction of FI ETFs likely face more binding capital constraints during the crisis period
- **Prediction**: non-FI ETFs managed by more constrained LMMs should experience greater pricing gaps, compared to non-FI ETFs that are managed by less constrained LMMs

$$\text{raw } |Premium|_{i,j,t} = \beta_0 + \beta_1 COVID_t + \beta_2 FI\ Weight_i * COVID_t + \beta_3 X_{i,t} + \alpha_i + \epsilon_{i,t}, \quad (5$$

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- $COVID_t$ is a dummy equals one for the period from Feb 20, 2020 to April 30, 2020
- $FI\ Weight_i$ is the continuous treatment variable defined at ETF-level, calculated as the weight of FI ETFs among all ETFs served by the focal ETF's LMM (measured at Dec 2019)
- We include ETF FE (α_i) in all specifications, absorbing the effect of $FI\ Weight_i$
- β_2 should be significantly positive

DiD Analysis of ETF Premium during COVID-19, result

Dep. Var = Raw $\lvert Premium \rvert$			
	Sample of Non-Fixed Income ETFs		
	(1)	(2)	(3)
COVID	20.464***	17.257***	
	(7.70)	(7.34)	
*FI Weight*COVID*		11.655***	9.350***
		(3.82)	(2.88)
Log (Size)			-3.209
			(-1.45)
STD			-1.304
			(-0.93)
BidAsk			3.665***
			(6.36)
Turnover			1.266***
			(3.23)
ETF FE	Y	Y	Y
Asset*Day FE			Y
Observations	152,170	152,170	152,170
R-squared	0.436	0.436	0.527

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ETF FE	Y	Y	Y
Asset*Day FE			Y
Observations	152,170	152,170	152,170
R-squared	0.436	0.436	0.527

- For a non-FI ETF managed by an LMM with a 75% weight in FI ETFs, the increase in its raw $\lvert Premium \rvert$ during the COVID-19 period is 4.68 bps higher than ETFs managed by an LMM with only 25% in FI ETFs

Subperiod analysis based on aggregate funding constraints

- The role of LMM-specific capital constraints is independent from the impacts of aggregate funding constraints
- We use the VIX index, the credit spread (CS), and the intermediary capital ratio of He, Kelly and Manela (2017) (HKM) as proxies for aggregate funding constraints

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Dep. Var = |*Premium*|						
	VIX		*Credit Spread*		*HKM*	
	Low	High	Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
LMM |*Premium*|	1.644***	1.758***	1.706***	1.678***	1.699***	1.694***
	(17.22)	(17.63)	(16.70)	(16.49)	(17.16)	(16.10)
Log (Size)	-2.401***	-4.086***	-3.028***	-3.863***	-3.575***	-3.330***
	(-5.98)	(-10.89)	(-7.50)	(-8.98)	(-8.50)	(-8.03)
STD	2.678***	1.667***	2.121***	2.012***	2.433***	1.547***
	(11.40)	(9.93)	(11.31)	(9.91)	(12.51)	(7.49)
BidAsk	7.374***	5.799***	6.280***	6.737***	6.453***	6.375***
	(22.73)	(21.83)	(21.63)	(19.94)	(22.33)	(18.90)
Turnover	0.432***	0.287**	0.634***	0.128	0.759***	0.18
	(2.64)	(2.05)	(4.24)	(0.76)	(4.87)	(1.28)
Asset*Day FE	Y	Y	Y	Y	Y	Y
ETF FE	Y	Y	Y	Y	Y	Y
Observations	1,512,415	1,433,863	1,671,942	1,274,334	1,716,307	1,229,971
R-squared	0.07	0.07	0.064	0.08	0.066	0.083

Outline

Implications for Investors and Financial Stability

- Investors increasingly use ETFs as the building block to construct portfolios
  - One key advantage of ETFs is that diversification across different asset classes, countries and factors become easy to implement
  - Most popular robo-advisors use ETFs to manage investors' wealth

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  - Most popular robo-advisors use ETFs to manage investors' wealth
- The excess ETF return comovement suggests that diversification benefits may be significantly reduced
  - especially during stressed periods when funding liquidity is constrained
- DiD test around COVID-19 suggests potential contagion of mispricing across asset classes and raise concerns for financial stability
  - inefficiencies in one segment of the ETF market can spillover to other segments through the sharing of common intermediaries

Conclusion

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- DiD analysis using extreme disruptions in debt markets during COVID-19
  - Non-FI ETFs managed by LMMs managing a larger fraction of FI ETFs experience greater pricing gaps

Summary statistics

Panel B. Summary Statistics of Main Variables

Variable	N	Mean	Std	Q1	Median	Q3
raw $\lvert Premium \rvert$ (bps)	2,946,278	25.48	31.99	4.44	12.59	33.21
$\lvert Premium \rvert$ (bps)	2,946,278	-0.02	22.8	-10.46	-1.9	5.81
LMM raw $\lvert Premium \rvert$ (bps)	2,946,278	25.74	9.51	19.2	24.81	31.04
LMM $\lvert Premium \rvert$ (bps)	2,946,278	-0.02	3.33	-1.96	-0.28	1.62
Log (Size)	2,946,278	18.81	2.27	17.16	18.77	20.38
STD (percent)	2,946,278	0.83	0.6	0.44	0.72	1.09
BidAsk (bps)	2,946,278	0.24	0.27	0.06	0.14	0.3
Turnover (bps)	2,946,278	1.36	2.41	0.38	0.68	1.28

LMM-level comovement in ETFs' raw premium

Dep.Var = Raw $\lvert Premium \rvert$				
	(1)	(2)	(3)	(4)
non-LMM raw $\lvert Premium \rvert$ (a)	0.954***			
	(2.69)			
LMM raw $\lvert Premium \rvert$ (b)	8.343***	5.664***	5.553***	2.406***
	(20.21)	(14.37)	(13.58)	(12.74)
Log (Size)		-0.232	-0.494	-3.031***
		(-0.59)	(-1.25)	(-8.71)
STD		2.100***	2.137***	2.272***
		(5.40)	(4.04)	(10.03)
BidAsk		11.215***	11.195***	7.018***
		(31.02)	(30.61)	(26.38)
Turnover		2.773***	2.827***	0.474***
		(6.37)	(6.39)	(3.43)
Asset*Day FE	N	N	Y	Y
ETF FE	N	Y	N	Y
Observations	2,946,278	2,946,278	2,946,278	2,946,278
R-squared	0.008	0.215	0.23	0.454
(b)-(a)	7.388***			
F-stat.	(10.13)			

Robustness I: Alternative fixed effects specifications

	Dep. Var.= |*Premium*|				
	(1)	(2)	(3)	(4)	(5)
LMM |*Premium*|	1.531***	1.510***	1.723***	1.447***	1.616***
	(16.99)	(19.01)	(18.15)	(15.06)	(17.10)
Log (Size)	-3.348***	-3.129***	-2.954***	-3.162***	-3.273***
	(-9.93)	(-9.75)	(-8.82)	(-9.05)	(-9.67)
STD	1.904***	1.248***	1.330***	1.325***	1.270***
	(10.04)	(6.64)	(7.24)	(7.17)	(6.86)
BidAsk	6.249***	6.473***	6.417***	6.425***	6.455***
	(25.14)	(26.14)	(24.88)	(26.09)	(25.87)
Turnover	0.472***	0.501***	0.503***	0.565***	0.489***
	(3.88)	(4.13)	(4.04)	(4.51)	(3.90)
ETF FE	Y	Y	Y	Y	Y
Other FE	Category*Day	Region*Day	Exchange*Day	Issuer*Day	Distributor*Day
Observations	2,916,565	2,944,228	2,762,151	2,903,629	2,885,229
R-squared	0.081	0.101	0.048	0.105	0.064

Robustness II: Comovement in pricing efficiency across asset classes

	Dep. Var.= |*Premium*|					
	Commodities (1)	Currencies (2)	Equities (3)	Fixed income (4)	Real estates (5)	Multi-asset (6)
LMM |*Premium*|	1.126***	0.269	1.910***	1.096***	2.163***	0.976***
	(2.69)	(0.90)	(16.94)	(6.77)	(3.49)	(3.38)
Log (Size)	0.329	-1.066	-3.740***	-2.568**	-4.909***	-0.482
	(0.15)	(-0.66)	(-10.63)	(-2.54)	(-3.35)	(-0.34)
STD	5.826***	7.791***	1.772***	1.114	2.241***	3.078***
	(7.46)	(4.78)	(10.41)	(1.17)	(2.68)	(3.77)
BidAsk	7.610***	3.997***	6.139***	8.990***	5.886***	6.083***
	(4.47)	(7.25)	(20.30)	(14.14)	(4.40)	(5.85)
Turnover	-0.482	0.221	0.678***	-0.471	-0.526	-0.482
	(-0.57)	(1.01)	(5.50)	(-1.21)	(-1.13)	(-0.41)
ETF FE	Y	Y	Y	Y	Y	Y
Day FE	Y	Y	Y	Y	Y	Y
Observations	57,191	32,546	2,121,625	534,083	71,459	129,374
R-squared	0.188	0.202	0.041	0.116	0.09	0.072

Robustness III: Comovement in pricing efficiency for ETFs covering different regions

Dep.Var = $\lvert Premium \rvert$							
	Emerging Markets (1)	Developed Markets (2)	Asia-Pacific (3)	Europe (4)	Global Ex-U.S. (5)	Global (6)	North America (7)
LMM $\lvert Premium \rvert$	3.144***	2.728***	3.411***	2.634***	2.518***	1.340***	0.461***
	(6.13)	(6.37)	(8.33)	(6.37)	(5.37)	(8.25)	(7.86)
Log (Size)	-2.911	-6.042***	-1.717	-3.432**	-3.574***	-2.684***	-3.008***
	(-1.59)	(-5.20)	(-1.44)	(-2.20)	(-2.93)	(-3.51)	(-7.52)
STD	1.822*	1.028	5.063***	4.008***	1.847*	1.970***	0.465**
	(1.84)	(0.81)	(9.70)	(4.28)	(1.87)	(5.43)	(2.33)
BidAsk	5.004***	8.221***	5.384***	5.656***	6.464***	6.104***	7.479***
	(7.88)	(11.86)	(6.72)	(8.44)	(8.40)	(13.22)	(15.45)
Turnover	1.001	0.336	1.167***	1.298***	0.279	0.459	-0.048
	(1.59)	(0.61)	(3.65)	(4.06)	(0.47)	(1.22)	(-0.36)
Asset*Day FE	Y	Y	Y	Y	Y	Y	Y
ETF FE	Y	Y	Y	Y	Y	Y	Y
Observations	140,640	123,448	220,273	152,249	155,741	524,352	1,550,826
R-squared	0.162	0.212	0.156	0.223	0.156	0.093	0.107