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**JACOBS LEVY EQUITY
MANAGEMENT CENTER**
FOR QUANTITATIVE FINANCIAL RESEARCH

Do ETFs Increase Volatility?

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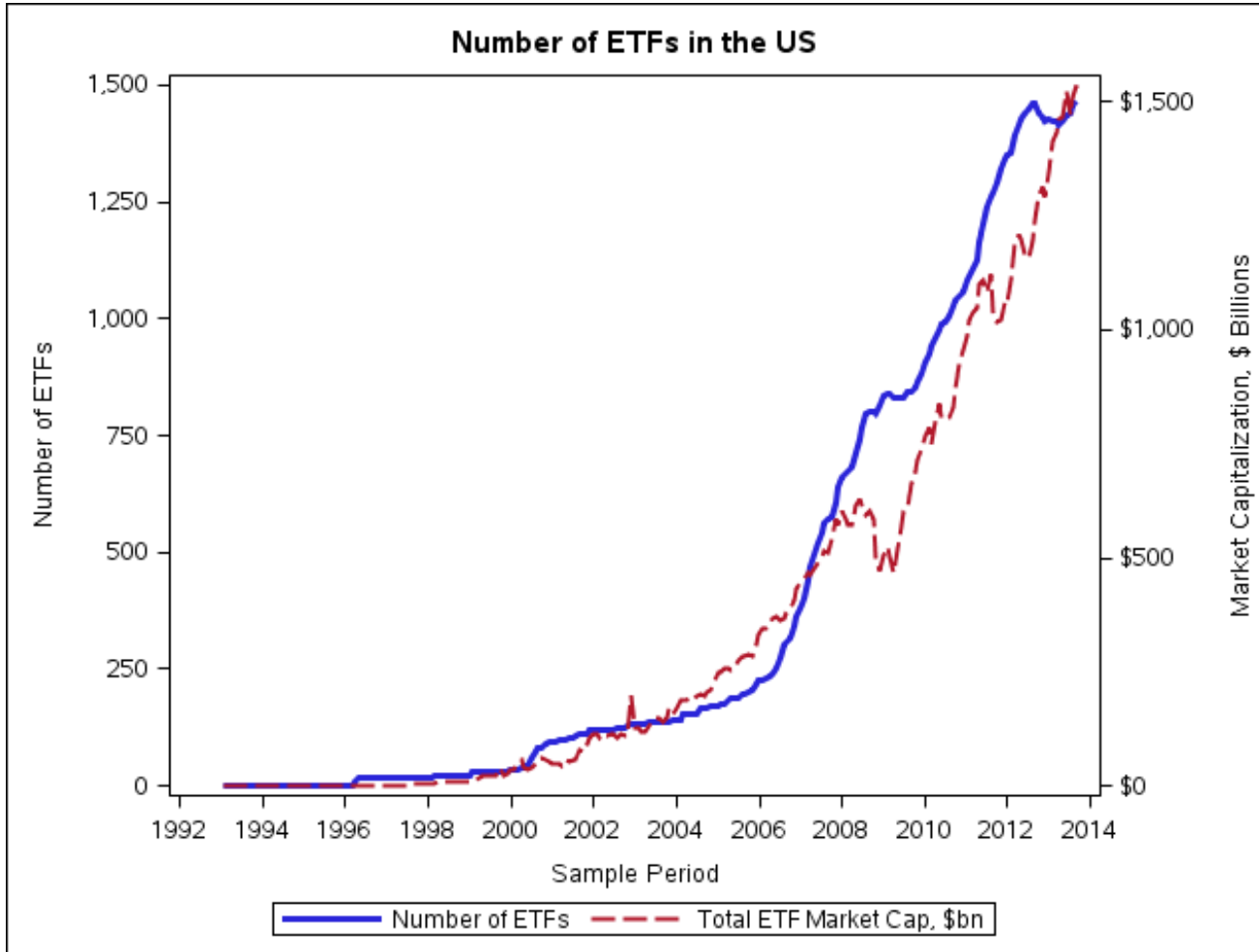
The Wharton School, University of Pennsylvania

Friday, April 25, 2014

ETF IS A SUCCESS STORY OF INNOVATION IN FINANCE

- Numerous benefits to retail investors & institutions
 - Highly liquid, cheap, and efficient instruments
 - Allow investors to enhance portfolio diversification
 - Give access to otherwise neglected corners of the market
 - Appealing for speculation and hedging purposes
 - Allow flexibility in entry/exit from pooled investments
- But, with some unintended consequences that could be better addressed once properly documented and understood

GROWTH IN ETF MARKET

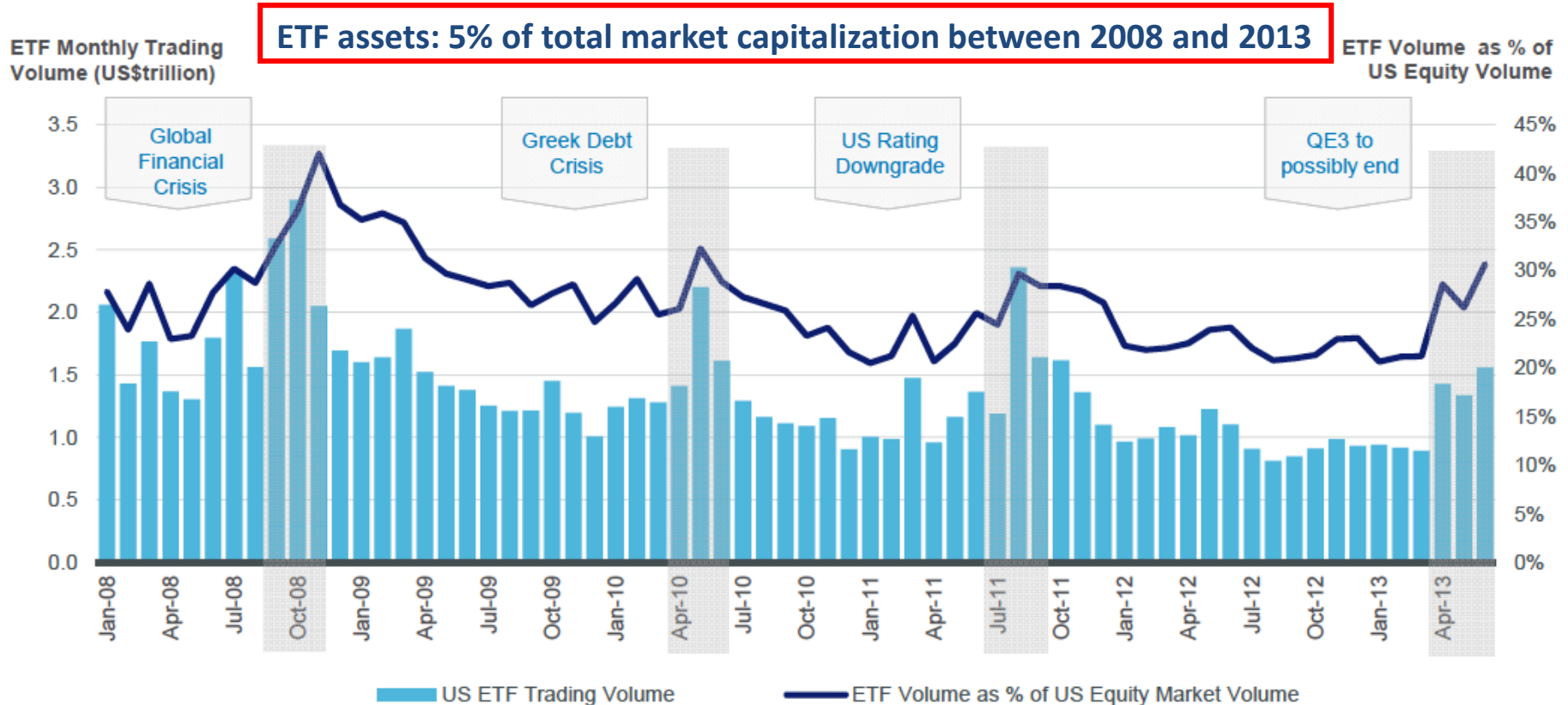


4,988 ETFs worldwide
1,466 ETFs in US

**ETF trading: up to
40% of volume in
U.S. markets
(31% in June 2013)**

ETF TRADING AS PERCENT OF AGGREGATE MARKET VOLUME

US LISTED ETF MONTHLY TRADING VOLUME AS A PERCENTAGE OF EQUITY MARKET VOLUME¹



NEW ISSUES ARE RAISED

- ETF are highly liquid instruments: attracting high turnover clientele
 - Hedge Funds and HFTs: speculation, arbitrage, and hedging
 - High trading volume and Excessive short interest
 - As a result of ETFs, the structure of demand of securities is likely to have changed: more intraday and arbitrage trading

- Raised concerns about hidden risks
 - Liquidity Risk: Flash Crash of May 6, 2010
 - Counterparty Risk: Synthetic ETFs (European ETFs)
 - Systemic Risk: impact of run on ETF assets on volatility and contagion

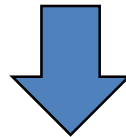
THIS PAPER:

Do ETFs increase volatility of underlying securities by amplifying their exposure to liquidity shocks through arbitrage?

1. Source: High turnover clientele inherited by the underlying stocks
2. ETF stock ownership adding a layer of non-fundamental volatility: intraday and daily volatility
3. Arbitrage channel: How are these shocks propagating to ETF baskets?

PREVIEW OF RESULTS: EFFECT ON VOLATILITY

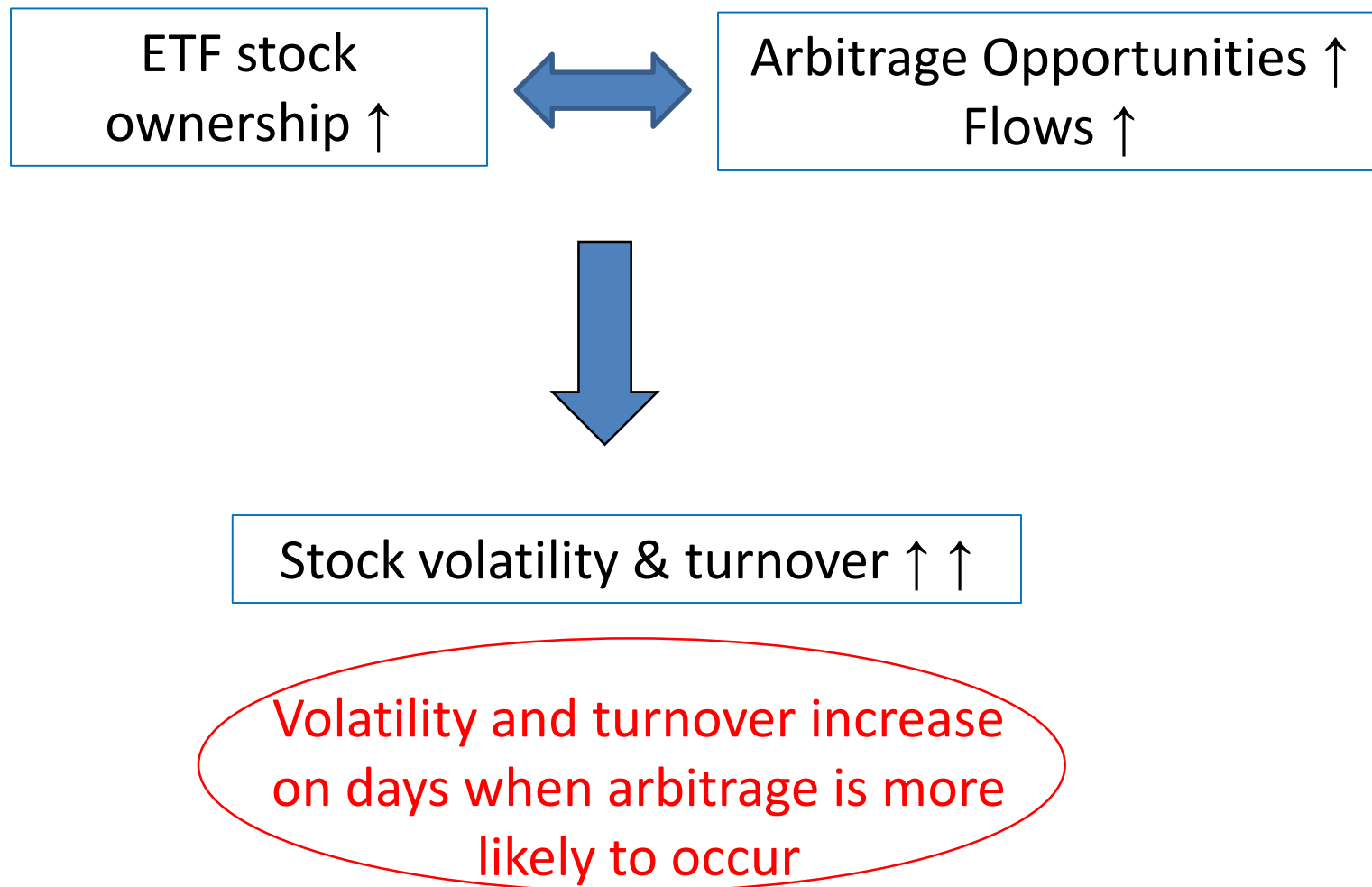
ETF stock ownership ↑



Stock volatility & turnover ↑

ETFs increase volatility and
turnover of underlying stocks

PREVIEW OF RESULTS: ARBITRAGE CHANNEL



EFFECT ON RETURNS: NON-FUNDAMENTAL VOLATILITY

ETF mispricing on day t \uparrow



NAV on day $t+1$ \uparrow
NAV on day $t+2$ \downarrow

Non-fundamental shock to
ETF price propagated to NAV

Regulators are wary of excessive high frequency volatility

“Excessive short-term volatility may indicate that long-term investors, even when they initially pay a narrow spread, are being harmed by short-term price movements that could be many times the amount of the spread”

SEC Concept release No. 34-61358

REGULATORY AGENCIES STARTED PAYING ATTENTION

- Flash-Crash Investigation: joint SEC-CFTC report
 - “Many of the securities experiencing the most severe price dislocations on May 6 were equity-based ETFs”
 - 65% of the cancelled trades were for ETFs
 - SPY was moving more closely with S&P500 eminis

- September 2013: Department of the Treasury, OFR Report on Asset Management and Financial Stability
 - Market vulnerability: “exchange traded funds (ETFs) may transmit or amplify financial shocks originating elsewhere”

 - “ETFs, like many pooled vehicles, could also potentially accelerate or amplify price movements in markets during market turbulence, thus reducing market liquidity”

EXCHANGE TRADED FUNDS (ETFs)

“ETFs are investment companies that are legally classified as open-end companies or Unit Investment Trusts (UITs)” (SEC)

- Different from standard funds in:

- Unlike Open-End Funds
 - Exchange listing/Intraday trading
- Unlike Closed-End Funds
 - In-kind creation/redemption



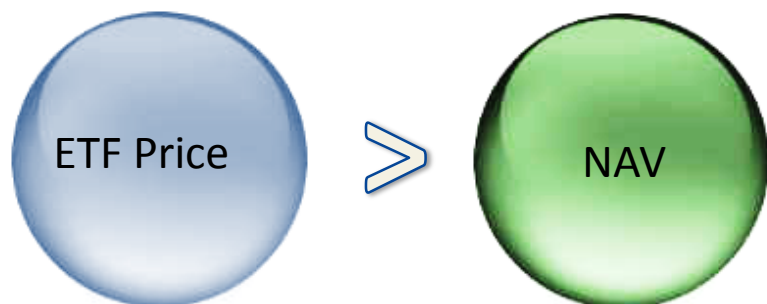
- ETF prices can deviate from NAV
- ETF prices are tied by ‘arbitrage’ to NAV

ETF ARBITRAGE

- For physical ETFs
- Primary market is made by Authorized Participants (APs): typically investment banks
- Flows in/out of ETFs induce share Creation/Redemption
 - ETF shares are most often created **in kind**
 - APs collect underlying securities and deliver them to ETF sponsor in exchange of ETF creation units: minimal fixed costs
 - ETF creation units: typically blocks of 50,000 ETF shares
- APs exploit discrepancies between ETF price and NAV
 - Share creation and redemption occurs to profit from arbitrage opportunities
 - The price of the ETF is kept in line with the NAV

ETF ARBITRAGE

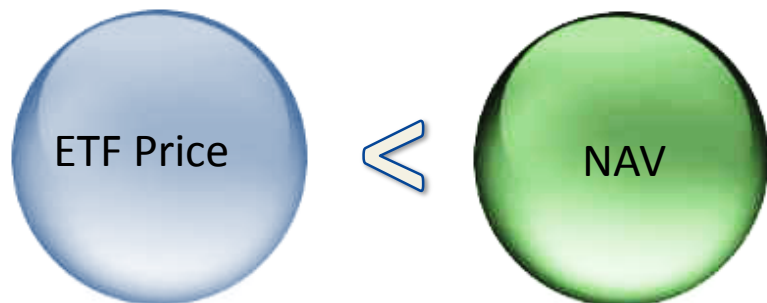
ETF Premium:



Authorized Participants:

- Buy underlying securities
- Short sell ETF shares
- Create ETF shares in kind
- Cover short ETF position

ETF Discount:



Authorized Participants:

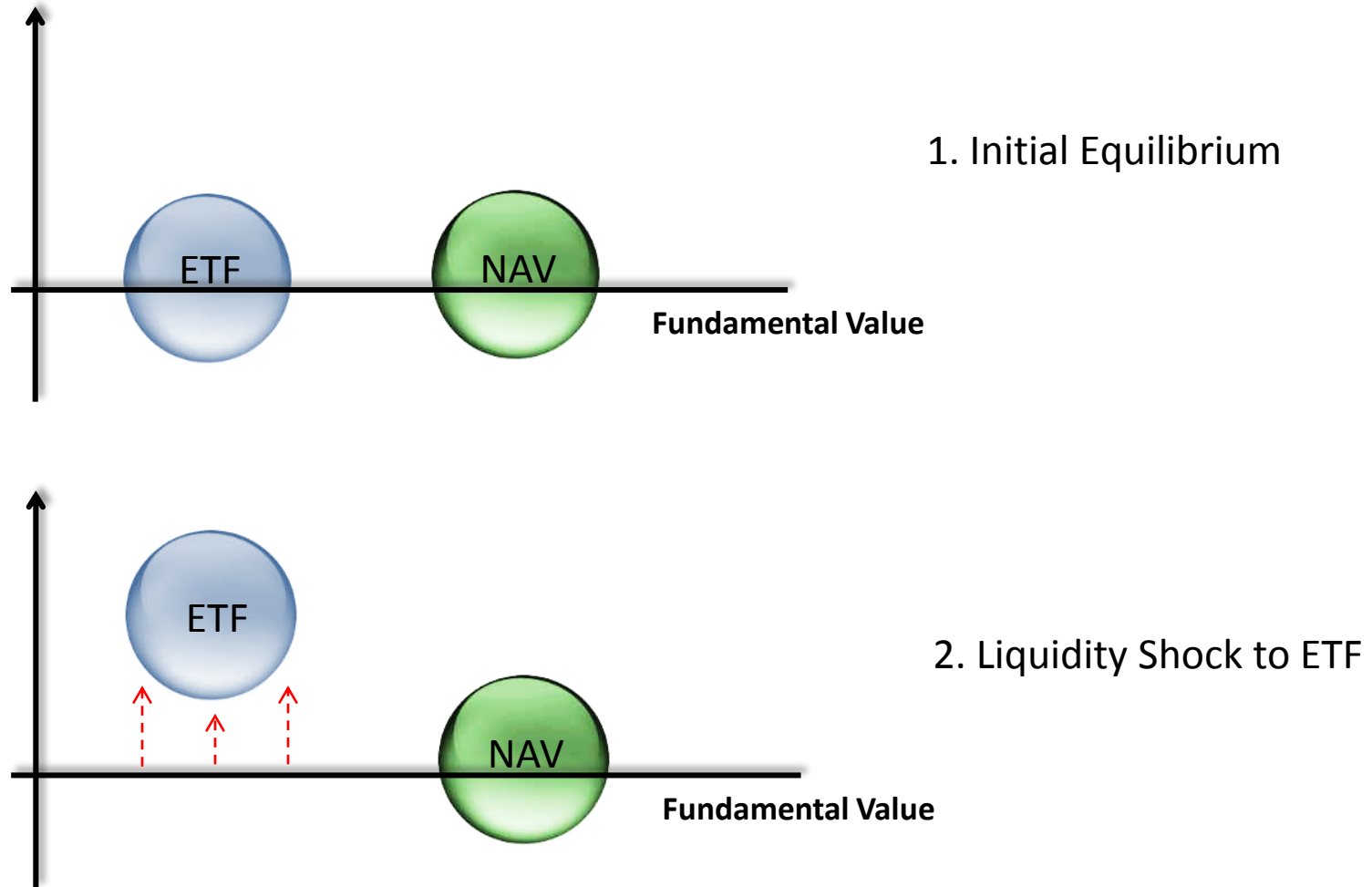
- Buy ETF in the market
- Short sell underlying
- Redeem ETF shares in kind
- Cover stock short positions

HIGHER FREQUENCY ARBITRAGE

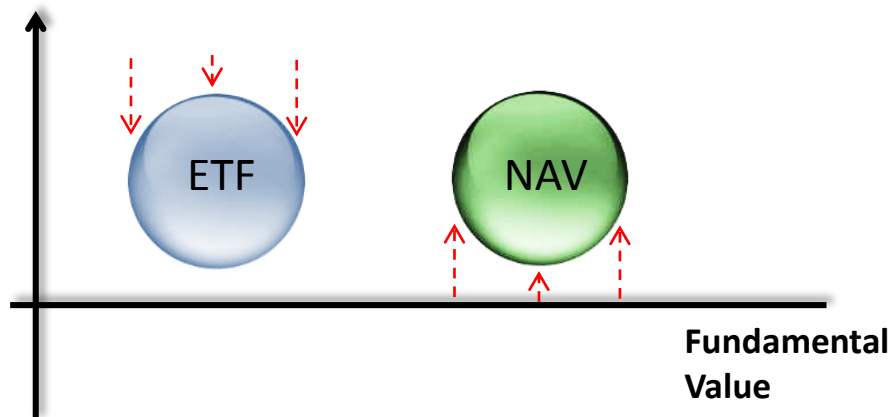
- Secondary Market Arbitrage:
 - HFTs & HFs taking long/short positions in ETFs and underlying
 - Wait for price convergence → close positions and realize arbitrage profits
 - Alternatively: use futures or other ETFs instead of underlying securities

- ***Risky and Limited Arbitrage:***
 - Execution risk for APs, Short selling costs
 - Non-fundamental risk and arbitrageurs' short horizon
 - Greenwood (2005): Arbitrageurs limited risk bearing capacity → can't wait too long for price convergence

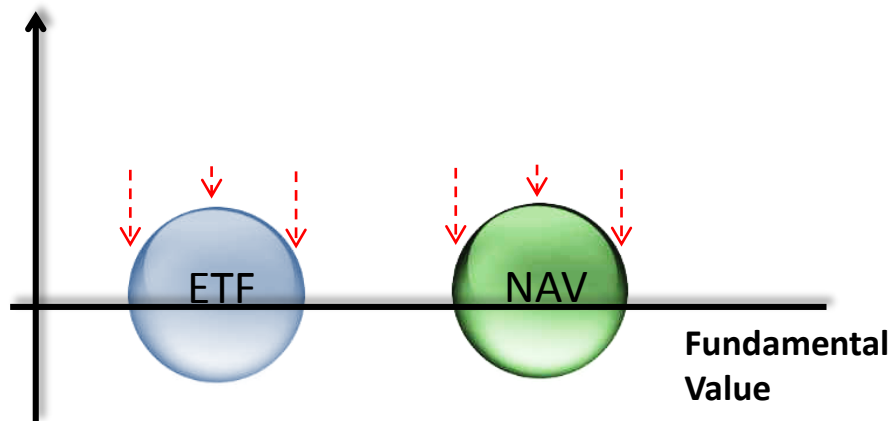
SHOCK PROPAGATION WITH LIMITED ARBITRAGE



SHOCK PROPAGATION WITH LIMITED ARBITRAGE



3. Hedging Demand by Arbitrageurs:
SHOCK PROPAGATION to NAV



4. Eventually Liquidity Flows
Back

RELATED LITERATURE

- Shock Propagation with Limited Arbitrage
 - Risk Averse Arbitrageurs: Greenwood (2005)
 - Liquidity Spillovers: Cespa and Foucault (2012)
- Impact on institutional flows on asset prices, expected returns and return comovements
 - Price pressure: Coval and Stafford (2007) and Khan, Kogan and Serafeim (2012)
 - Exacerbating return comovement and distorting risk-return tradeoffs: Wurgler (2010), Sullivan and Xiong (2012), Broman (2013)
 - “Index” effect and “Asset class” effect: Basak and Pavlova (2012)

ETF LITERATURE

- ETF mispricing and trading strategies
Engle and Sarkar (2006), Marshall, Nguyen, and Visaltanachoti (2010), Petajisto (2011)
- Effects of ETF on Volatility and Liquidity
Trainor (2010), Bradley and Litan (2010), Krause, Ehsani, Lien (2013), Tuzun (2012), Haryanto Rodier Shum and Hejazi (2013)
- ETF and Settlement Failures (Fails to Deliver) causing higher market index volatility
Stratman and Welborn (2012), Bansal, McKeon, Svetina (2013)
- ETFs, Market Segmentation and Flash Crash
Madhavan (2013)
- ETF and comovement of basket stocks:
Da and Shive (2013): Direct implication of our findings

DATA

- CRSP and Compustat: identify 1,673 ETFs
 - Monthly volatility using daily returns
- CRSP MFDB (Lipper), Morningstar: objective codes, NAV (daily)
 - Focus on US Equity ETFs (most liquid): 660 ETFs
- Bloomberg: correct daily-updated shares outstanding → net flows
- Compustat and OptionMetrics: fill gaps in daily shares outstanding
- Russell 3000 and S&P 500 constituents data on a daily basis
- Thomson-Reuters Mutual Fund: ETF holdings in stocks (quarterly)
- Markit Securities Finance: 7-day average lending fee

- Intraday Data: TAQ
 - ETF Prices at 4pm
 - Daily stock volatility using intraday second-by-second returns

- Sample Period: 2000-2012

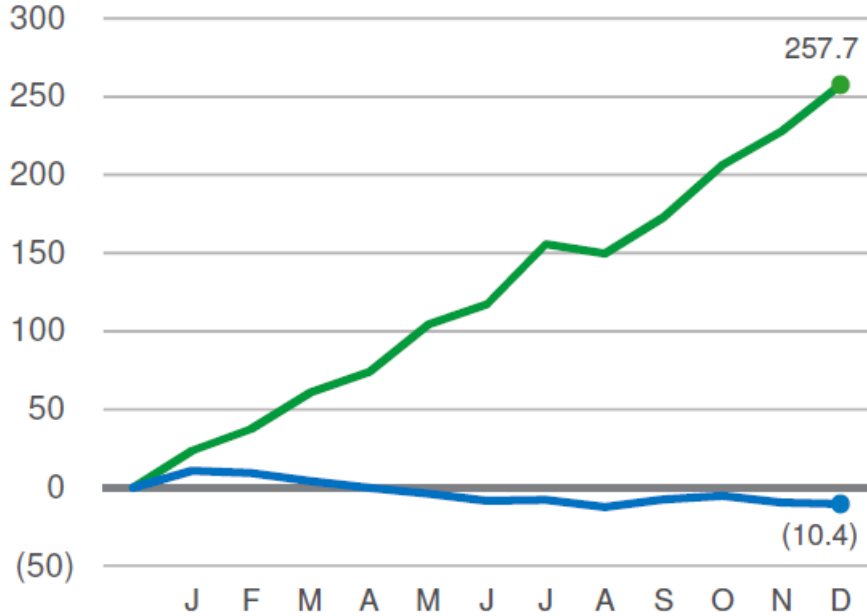
ETF OWNERSHIP IN LARGE CAP AND RUSSELL 3000 STOCKS

Year	S&P 500			Russell 3000		
	#ETFs	Average stock weight in ETF (%)	Average ownership of ETF in firm (%)	#ETFs	Average stock weight in ETF (%)	Average ownership of ETF in firm (%)
2000	2.45	0.64	0.27	2.41	0.53	0.30
2001	13.45	0.42	0.63	8.91	0.16	0.37
2002	15.47	0.45	0.88	10.18	0.14	0.71
2003	15.95	0.45	1.00	10.42	0.14	0.85
2004	21.40	0.47	1.06	14.30	0.14	1.11
2005	24.74	0.49	1.37	15.73	0.16	1.37
2006	25.80	0.51	1.68	16.81	0.17	1.85
2007	36.04	0.64	1.97	22.60	0.24	2.17
2008	50.61	0.69	2.69	30.26	0.28	2.81
2009	53.19	0.67	3.11	31.30	0.26	3.41
2010	52.04	0.68	3.16	30.08	0.27	3.60
2011	52.77	0.67	3.52	28.87	0.27	3.77
2012	48.59	0.68	3.78	26.93	0.26	3.82
Average	30.43	0.57	1.90	20.01	0.21	2.10

MORE FLOWS THAN EQUITY MUTUAL FUNDS IN 2013!

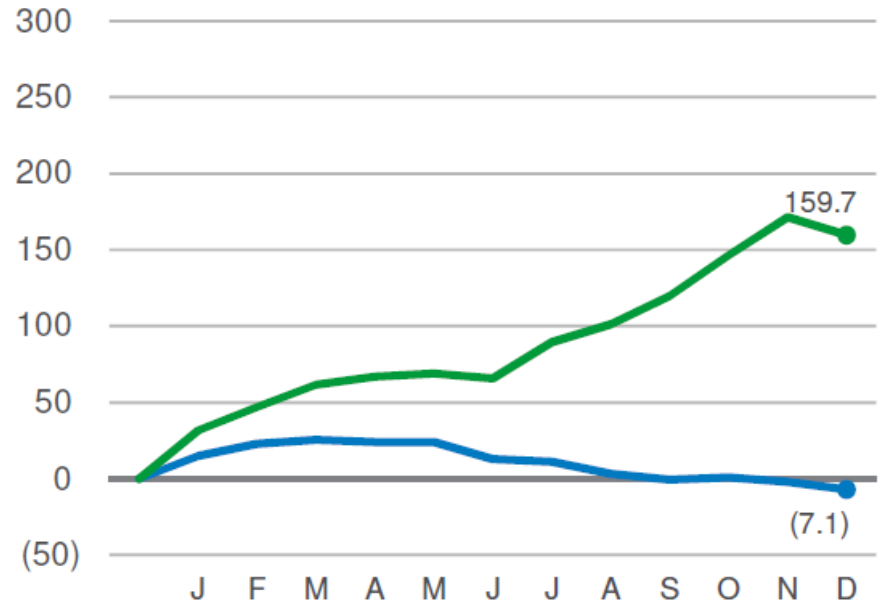
GLOBAL EQUITY ETP FLOWS^{1,4}

2013 Flows: \$247.3bn



GLOBAL EQUITY MUTUAL FUND FLOWS^{1,4}

2013 Flows: \$152.6bn



— Developed Markets Flows
— Emerging Markets Flows

IDENTIFICATION STRATEGY

Question: Does ETF ownership impact stock volatility and turnover?

$$ETF\ ownership_{i,t} = \frac{\sum_{j=1}^J w_{i,j,t} AUM_{j,t}}{Mkt\ Cap_{i,t}},$$

- Variation in ETF ownership across stocks
 - Same stocks has different weights in various indexes
 - Representative sampling by many ETFs
 - Each stock is owned by several ETFs (broad based, sector, etc.)
- Time series variation in ETF ownership
 - ETF AUM
 - Entry and exit into ETF market
- Identifying assumption: variation in ETF ownership is exogenous
 - Explicit controls for stock size and liquidity in all specifications
 - Stock and date fixed effects

DO ETFs INCREASE STOCK VOLATILITY AND TURNOVER?

- Increased volume for stocks in ETF baskets
 - ETFs: Higher liquidity + cheaper transaction cost
 - Amihud & Mendelson (1986): ETFs **attract** high-turnover clientele
 - High turnover investors **generate** high noise trading
 - Underlying stocks **inherit** from ETFs those investors with high frequency trading due to **arbitrage** activity

- Non-fundamental volatility for underlying stocks is increased by ETF ownership
 - Does such high frequency volatility survive over longer horizons?

INTRADAY VOLATILITY AND DAILY TURNOVER

Sample:	S&P 500		Russell 3000	
	Volatility	Turnover	Volatility	Turnover
ETF ownership (t-1)	0.243*** (7.461)	11.631*** (8.773)	0.069*** (8.883)	4.026*** (10.027)
log(Mktcap (t-1))	0.004*** (5.356)	-0.194*** (-5.552)	-0.003*** (-10.781)	0.077*** (9.068)
1/Price (t-1)	0.195*** (12.929)	1.202** (2.263)	0.032*** (12.631)	-0.044 (-1.048)
Amihud (t-1)	-0.333 (-1.038)	-123.183*** (-7.548)	0.020*** (8.656)	-1.141*** (-15.669)
Bid-ask spread (t-1)	-0.119* (-1.872)	-7.636*** (-5.516)	-0.006 (-0.264)	-10.096*** (-13.161)
Observations	1,472,346	1,472,346	7,687,652	7,687,652
Adjusted R ²	0.466	0.464	0.451	0.381

- ETFs increase the intraday volatility of underlying stocks
 - For S&P 500 stocks: \uparrow 1 std in ETF ownership \rightarrow \uparrow 18.9% of std in intraday volatility
 - Lower economic significance for smaller stocks (8% of std):
 \rightarrow arbitrageurs concentrate in larger and more liquid stocks to reduce costs
- Turnover: increased exposure (\uparrow 19.1% of std) of stocks in ETF baskets to liquidity trading

THE EFFECT PERSISTS IN DAILY RETURNS

Dependent variable:	Daily stock volatility (computed within the month)	
	S&P 500	Russell 3000
ETF ownership (average within the month)	0.144*** (8.190)	0.041*** (7.051)
log(Mktcap (t-1))	-0.159*** (-2.917)	-0.259*** (-12.444)
1/Price (t-1)	6.494*** (7.250)	2.750*** (11.937)
Amihud (t-1)	87.364*** (4.256)	0.453* (1.646)
Bid-ask spread (t-1)	23.586** (2.454)	3.692 (1.078)
Observations	51,349	311,079
Adjusted R ²	0.630	0.557

- Effect of ETF ownership on volatility does not wash away in daily returns
 - More relevant for long term investors
 - For S&P 500 stocks: \uparrow 1 std ETF ownership \rightarrow volatility \uparrow by 16.1% of a std
 - Effects are less economically significant for smaller stocks
- Conclusion: ETFs are catalysts for demand shocks that affect underlying securities

CONFIRM ARBITRAGE CHANNEL

- Arbitrage trades occur at a different frequencies
 - Intraday: High frequency arbitrage
 - Continuously taking place between ETFs and underlying securities

- Mispricing is signal (profitability) for arbitrage trading

$$ETF\ mispricing_{j,t} = \frac{ETF\ price_{j,t} - NAV_{j,t}}{ETF\ price_{j,t}}$$

- Construct stock level average:

$$abs(ETF\ mispricing_{i,t}) = \frac{\sum_{j=1}^J |Mispricing_{j,t}| * ETF\ ownership_{i,j,t}}{\sum_{j=1}^J ETF\ ownership_{i,j,t}}$$

- Share creation and redemption
 - Focusing on arbitrage activities by Authorized Participants
 - Observed at day end: Net Flows

- Evidence on magnifying effect of Mispricing and Flows

ARBITRAGE CHANNEL: MISPRICING

Sample: Dependent variable:	S&P 500		Russell 3000	
	Intraday volatility	Intraday turnover	Intraday volatility	Intraday turnover
	(1)	(2)	(3)	(4)
ETF ownership (t-1)	0.186*** (5.814)	10.371*** (8.038)	0.068*** (8.633)	4.005*** (9.949)
× abs(ETF mispricing (t-1))	42.035*** (9.876)	896.893*** (6.860)	-0.113 (-0.417)	-2.660 (-0.350)
abs(ETF mispricing (t-1))	0.006*** (2.749)	0.207** (2.459)	-0.005 (-0.943)	-0.085 (-0.811)
	Size and Liquidity Controls + Stock and Day Fixed Effects			
Observations	1,471,139	1,471,139	7,679,072	7,679,072
Adjusted R ²	0.470	0.465	0.452	0.381

- Volatility and turnover increase on days when arbitrage is most likely to occur
 - Mispricing $\neq 0 \rightarrow$ Arbitrage \rightarrow higher volatility and turnover \uparrow
- Average stock (1.9% ETF ownership): \uparrow 1 std in mispricing \rightarrow \uparrow 85.4% of std in intraday volatility, and \uparrow 26.3% of std in turnover
- Effect is not significant for smaller stocks

FLows AS A MAGNIFYING FACTOR

Sample: Dependent variable:	S&P 500		Russell 3000	
	Intraday volatility	Intraday turnover	Intraday volatility	Intraday turnover
	(1)	(2)	(3)	(4)
ETF ownership (t-1)	0.229*** (7.003)	10.305*** (7.996)	0.068*** (8.846)	3.328*** (8.269)
× abs(ETF flows (t-1))	3.197*** (5.861)	232.101*** (5.988)	0.141* (1.688)	70.306*** (8.298)
abs(ETF flows (t-1))	-0.009*** (-4.521)	-0.090 (-1.491)	-0.000* (-1.893)	-0.129*** (-3.466)
	Size and Liquidity Controls + Stock and Day Fixed Effects			
Observations	1,471,139	1,471,139	7,679,072	7,679,072
Adjusted R ²	0.467	0.466	0.452	0.381

- Flows are a significant magnifying factor for ownership
 - Flows $\neq 0$ \rightarrow Trading in underlying securities \uparrow \rightarrow higher volatility and turnover \uparrow
- At mean level of ownership (1.9%), $\uparrow 1$ std in Flows \rightarrow $\uparrow 3.7\%$ of std in volatility & $\uparrow 6.6\%$ of std in turnover
- Weaker effect of flows than mispricing because flows measure lower frequency arbitrage
 - But stronger effect on small stocks

NON-FUNDAMENTAL SHOCKS: RETURN REVERSALS

- *Non-fundamental shocks cause return reversals*
- Confirm arbitrage channel: price pressure
 - Do ETF Mispricing and Flows at (t-1) predicts NAV at (t)?
 - Demand pressures on NAV due to mispricing arbitrage and flows
- Non-fundamental shocks vs. early price discovery
 - Do ETF Mispricing at (t-1) predict reversals after (t+1)?
 - NAV reversal proportional to ETF ownership and arbitrage activity

REVERSALS FROM NON-FUNDAMENTAL SHOCKS

	S&P 500					S&P 500			
	Ret(t)	Ret(t+1,t+5)	Ret(t+1,t+10)	Ret(t+1,t+20)		Ret(t)	Ret(t+1,t+5)	Ret(t+1,t+10)	Ret(t+1,t+20)
	(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)
ETF ownership (t-1)	0.662*** (3.410)	-2.630*** (-2.901)	-5.866*** (-3.316)	-10.678*** (-3.048)	ETF ownership (t-1)	0.612*** (3.124)	-2.453*** (-2.705)	-5.658*** (-3.186)	-10.313*** (-2.941)
× ETF mispricing (t-1)	321.266*** (3.615)	-492.213*** (-2.929)	-308.665 (-1.061)	-1,421.138** (-2.519)	× ETF flows (t)	16.245* (1.878)	-134.935*** (-5.034)	-237.910*** (-8.528)	-222.293*** (-5.830)
ETF mispricing (t-1)	1.043*** (3.843)	0.232 (0.593)	-1.614*** (-3.331)	-1.671** (-2.359)	ETF flows (t)	0.255* (1.942)	-1.689*** (-3.104)	-2.894*** (-5.232)	-4.062*** (-4.629)
Size and Liquidity Controls	Yes	Yes	Yes	Yes	Size and Liquidity Controls	Yes	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes	Yes	Stock fixed effects	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Day fixed effects	Yes	Yes	Yes	Yes
Observations	1,426,141	1,426,141	1,426,141	1,426,141	Observations	1,419,903	1,419,903	1,419,903	1,419,903
Adjusted R ²	0.325	0.299	0.278	0.281	Adjusted R ²	0.326	0.299	0.279	0.281

- Stronger effect for stocks with higher ETF ownership and greater mispricing & flows
 - Positive price impact on first day, and return reversals on the following days
 - Mispricing > 0 → Arbitrage → NAV ↑ initially then ↓ afterwards
 - Flows > 0 → NAV ↑ initially then ↓ afterwards
- Conclusion: arbitrage propagates non-fundamental shocks

CORROBORATING EVIDENCE: LIMITS-TO-ARBITRAGE

- Conjectured channel for shock propagation: arbitrage
 - If this is correct, then we should expect smaller effect on stocks for which arbitrage is costlier or more restricted
 - Costs for ETF arbitrageurs:
 - Bid-Ask spread: round trip arbitrage transaction cost
 - Stock lending fee:
 - Split the sample by Low vs. High costs of arbitrage
-

STRONGER EFFECTS FOR LOW BID-ASK SPREAD STOCKS

Sample: Dependent variable: Bid-ask spread (t-1):	S&P 500				Russell 3000			
	Intraday volatility		Intraday turnover		Intraday volatility		Intraday turnover	
	Low	High	Low	High	Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ETF ownership (t-1)	0.142*** (4.833)	0.168*** (4.169)	10.017*** (7.050)	8.286*** (5.462)	0.094*** (8.944)	0.066*** (7.257)	3.564*** (6.480)	4.195*** (9.764)
× abs(ETF mispricing (t-1))	50.828*** (12.241)	17.244*** (5.869)	750.869*** (5.204)	764.789*** (5.591)	0.736*** (3.767)	-0.197 (-0.955)	21.775** (2.227)	-11.773* (-1.956)
Observations	735,570	735,569	735,570	735,569	3,839,536	3,839,536	3,839,536	3,839,536
Adjusted R ²	0.488	0.522	0.544	0.436	0.407	0.474	0.401	0.362

Sample: Dependent variable: Bid-ask spread (t-1):	S&P 500				Russell 3000			
	Intraday volatility		Intraday turnover		Intraday volatility		Intraday turnover	
	Low	High	Low	High	Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ETF ownership (t-1)	0.205*** (6.813)	0.169*** (4.262)	9.918*** (6.834)	7.760*** (5.344)	0.099*** (9.495)	0.064*** (7.130)	3.023*** (5.581)	3.562*** (8.188)
× abs(ETF flows (t))	4.231*** (7.632)	2.648*** (4.580)	275.046*** (9.243)	197.370*** (4.609)	-0.096 (-0.979)	0.239** (2.456)	74.942*** (12.255)	55.122*** (6.068)
Observations	735,568	735,571	735,568	735,571	3,839,536	3,839,536	3,839,536	3,839,536
Adjusted R ²	0.482	0.522	0.545	0.438	0.407	0.474	0.401	0.362

- Smaller stocks being more subject to limits to arbitrage
- Arbitrage: more costly → impact of arbitrage proxies on volatility and turnover are reduced

STRONGER EFFECTS FOR LOW LENDING FEES STOCKS

Sample:	S&P 500				Russell 3000			
Dependent variable:	Intraday volatility		Intraday turnover		Intraday volatility		Intraday turnover	
Rebate rate:	Low	High	Low	High	Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ETF ownership (t-1)	0.085*** (5.327)	0.026* (1.854)	6.587*** (5.845)	5.601*** (5.076)	0.037*** (8.026)	0.044*** (7.162)	2.813*** (6.827)	1.969*** (4.164)
× abs(ETF mispricing (t-1))	21.480*** (5.072)	18.856*** (4.503)	1,467.626*** (5.320)	783.211*** (3.807)	2.221*** (2.606)	-0.536*** (-2.767)	324.516*** (3.950)	-2.942 (-0.557)
Observations	366,618	366,618	366,618	366,618	2,088,566	2,088,563	2,088,566	2,088,563
Adjusted R ²	0.518	0.582	0.504	0.524	0.477	0.520	0.458	0.428

Sample:	S&P 500				Russell 3000			
Dependent variable:	Intraday volatility		Intraday turnover		Intraday volatility		Intraday turnover	
Rebate rate:	Low	High	Low	High	Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ETF ownership (t-1)	0.107*** (6.442)	0.047*** (3.128)	7.899*** (7.013)	6.312*** (5.739)	0.034*** (7.370)	0.040*** (6.541)	2.321*** (6.005)	1.200** (2.510)
× abs(ETF flows (t))	0.953 (1.639)	0.263 (0.753)	98.639** (2.485)	48.965 (1.234)	0.684*** (7.212)	0.375*** (4.292)	100.294*** (12.066)	83.037*** (6.767)
Observations	366,618	366,618	366,618	366,618	2,088,566	2,088,563	2,088,566	2,088,563
Adjusted R ²	0.518	0.582	0.503	0.524	0.477	0.520	0.459	0.429

lending fees are high: arbitrage less likely → ETF ownership does not increase volatility as much for a level of mispricing or flows

→ Consistent with Arbitrage being the driving factor

CONCLUSION

- ETFs are probably one of the most successful innovations in finance in the last years
- Unintended consequence of financial innovation
 - Dense networks of arbitrage relations
 - Facilitating rapid transmission of liquidity shocks
- ETFs contribute to amplification of noise and non-fundamental volatility in financial markets due to arbitrage
- ETF ownership effect on stock volatility persists in longer frequencies: impact on long term investors