Risk and Portfolio Management Spring 2011

Exchange Traded Funds:

A general introduction

Exchange-traded funds

ETF: Investment vehicles similar to mutual funds but "look like stocks"
> -- traded on an exchange
> -- trading is similar to stocks (long, short, margin)

ETF: can be viewed as a holding company or a fund
> -- started as index trackers
> -- actively managed ETFs since mid 2000's

Arbitrage: authorized participants can **create or redeem** ETFs in ``creation units''
> -- creation units: 25K to 100K shares
> -- APs often act as market makers, providing liquidity

History

Milestones:

1993: first US ETF

1998: first European ETFs

2008: first actively managed ETFs

History:

1989: Index Participation Shares, stopped by Chicago Mercantile Exchange

1993: SPY Tracking S&P 500 (a.k.a. Spiders or SPDRS, issuer: State Street)

1996: BGI creates WEBS (World Equity Benchmark Shares), later called I-Shares

1998: Sector SPDRS track 9 sectors of the S&P 500

2008: 680 ETFs in US with 610B in assets, increase of 125B in 12 months

 January 2010: US ETF market breaks the 1,000 billion mark in AUM

Global ETF asset growth, as at end August 2009

Assets US$ Bn

ETFs
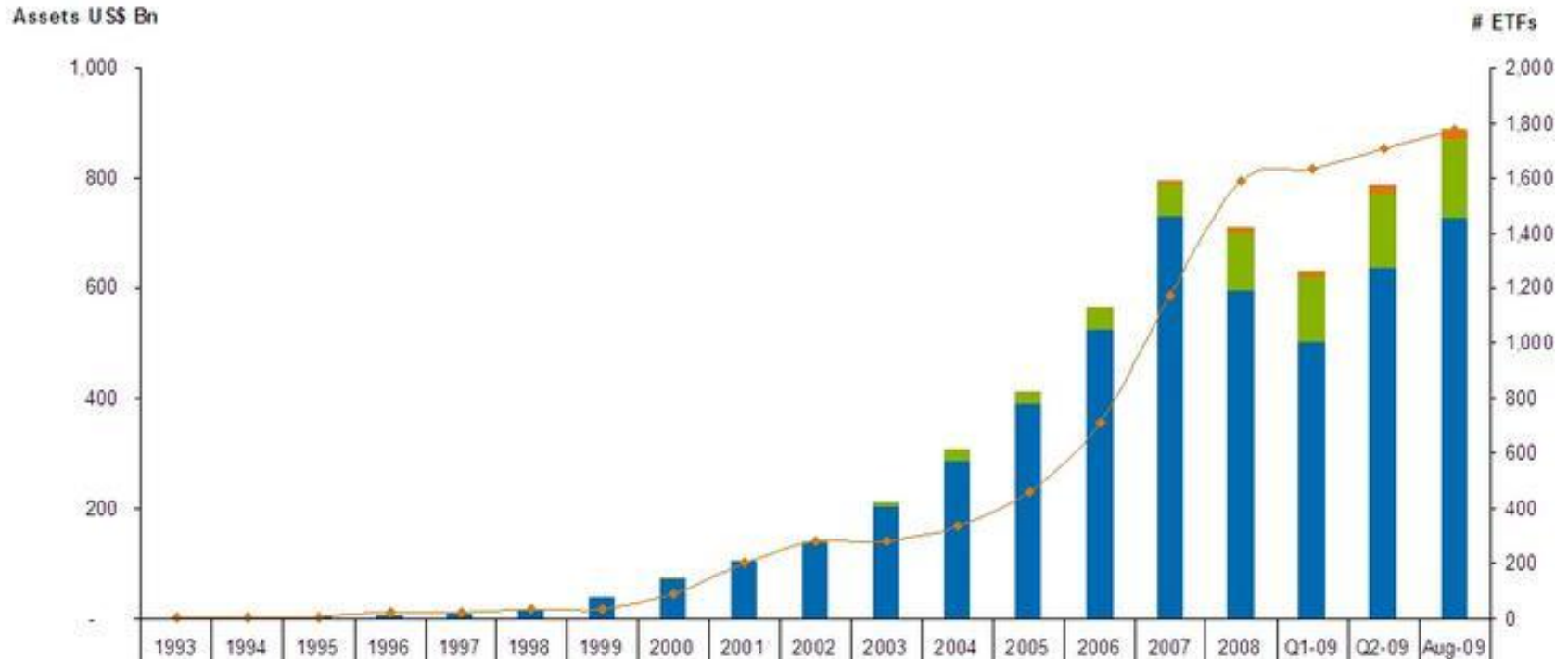
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Q1-09	Q2-09	Aug-09
ETF Assets Total	$1	$1	$2	$5	$8	$18	$40	$74	$105	$142	$212	$310	$412	$566	$797	$711	$633	$789	$891
ETF Commodity Assets									$0	$0	$0	$0	$1	$3	$6	$10	$13	$16	$18
ETF Fixed Income Assets								$0	$0	$4	$6	$23	$21	$36	$60	$104	$116	$133	$145
ETF Equity Assets	$1	$1	$2	$5	$8	$18	$40	$74	$105	$138	$206	$286	$390	$526	$730	$596	$503	$639	$727
# ETFs	3	3	4	21	21	31	33	92	202	280	282	336	461	714	1172	1592	1634	1707	1,773

Largest issuers

Top 5 ETF providers around the world ranked by AUM, as at end August 2009

PROVIDER	Aug-09			YTD CHANGE				
	# ETFs	AUM (US$ BN)	% TOTAL	# ETFs	% ETFs	AUM (US$ BN)	% AUM	% MARKET SHARE
iShares	391	$429.32	48.2%	29	8.0%	$100.84	30.7%	2.0%
State Street Global Advisors	104	$139.33	15.6%	6	6.1%	-$6.67	-4.6%	-4.9%
Vanguard	40	$71.71	8.1%	2	5.3%	$26.55	58.8%	1.7%
Lyxor Asset Management	102	$40.78	4.6%	-13	-11.3%	$7.32	21.9%	-0.1%
db x-trackers	110	$31.34	3.5%	12	12.2%	$7.27	30.2%	0.1%

Source: ETF Research and Implementation Strategy Team, Barclays Global Investors, Bloomberg

ETFs by Asset Class

Global ETF assets by type of exposure, ranked by AUM, as at end August 2009

Region of Exposure	Aug-09				YTD Change				
	# ETFs	Total Listings	AUM (US$ BN)	% TOTAL	# ETFs	Total Listings	AUM Change	% AUM	% TOTAL
Equity	1,439	2,558	$726.90	81.6%	95	306	$130.00	21.8%	-2.3%
North America - Equity	474	650	$378.11	42.5%	2	24	$35.31	10.3%	-5.8%
Emerging Markets - Equity	259	522	$122.76	13.8%	29	77	$51.84	73.1%	3.8%
Europe - Equity	400	841	$98.88	11.1%	50	147	$23.28	30.8%	0.5%
Asia Pacific - Equity	144	234	$61.58	6.9%	9	23	$9.36	17.9%	-0.4%
Global - Equity	100	243	$15.45	1.7%	3	30	$4.55	41.7%	0.2%
Global (ex-US) - Equity	62	68	$50.13	5.6%	2	5	$5.65	12.7%	-0.6%
Fixed Income	232	417	$144.90	16.3%	71	124	$41.14	39.6%	1.7%
Fixed Income - All (ex-Cash)	215	384	$135.98	15.3%	67	116	$44.56	48.8%	2.4%
Fixed Income - Cash (Money Market)	17	33	$8.93	1.0%	4	8	-$3.42	-27.7%	-0.7%
Commodities	58	118	$17.72	2.0%	10	40	$8.15	85.2%	0.6%
Mixed (Equity & Fixed Income)	28	28	$0.43	0.0%	2	2	$0.15	53.2%	0.0%
Currency	14	14	$0.52	0.1%	1	1	$0.13	34.5%	0.0%
Alternative	2	2	$0.05	0.0%	2	2	$0.05	100.0%	0.0%
Total	1,773	3,137	$890.52	100.0%	181	475	$179.62	25.3%	

Source: ETF Research and Implementation Strategy Team, Barclays Global Investors, Bloomberg

March 2011, from ETFChannel.com, 60 Largest ETFs by AUM

Rank	Ticker	Description	Market Cap	Rank	Ticker	Description	Market Cap
1	SPY	SPDR S&P 500	90.21	31	VEU	Vanguard FTSE All-World ex-US	7.21
2	GLD	SPDR Gold Shares	56.03	32	JNK	SPDR Barclays Capital High	7.06
3	VWO	Vanguard MSCI Emerging Markets	43.73	33	IWB	iShares Russell 1000 Index	7.00
4	EFA	iShares MSCI EAFE Index	38.15	34	PFF	iShares S P U	6.79
5	EEM	iShares MSCI Emerging Markets	36.24	35	XLK	Technology Select Sector SPDR	6.79
6	IVV	iShares S&P 500 Index	26.95	36	EWJ	iShares MSCI Japan Index	6.47
7	QQQQ	PowerShares QQQ	24.21	37	IWR	iShares Russell Midcap Index	6.37
8	TIP	iShares Barclays TIPS Bond	19.89	38	VIG	Vanguard Dividend Appreciation ETF	6.10
9	VTI	Vanguard Total Stock Market	18.98	39	IVW	iShares S&P 500 Growth	6.05
10	IWM	iShares Russell 2000 Index	15.39	40	DVY	iShares Dow Jones Select	5.99
11	IWF	iShares Russell 1000 Growth	13.29	41	EWC	iShares MSCI Canada	5.97
12	LQD	iShares iBoxx Investment Grade	12.98	42	TBT	Proshares UltraShort 20+tsy	5.68
13	EWZ	iShares MSCI Brazil Index	12.54	43	IAU	iShares Gold Trust	5.67
14	SLV	iShares Silver Trust	12.38	44	VUG	Vanguard Growth ETF	5.42
15	IWD	iShares Russell 1000 Value	11.80	45	SDY	SPDR S&P Dividend	5.37
16	VEA	Vanguard MSCI EAFE ETF	11.34	46	VTV	Vanguard Value ETF	4.84
17	MDY	SPDR S&P MidCap 400	11.11	47	VB	Vanguard Small-Cap ETF	4.64
18	AGG	iShares Barclays Aggregate Bond	11.06	48	VV	Vanguard Large-Cap ETF	4.61
19	BSV	Vanguard Short-Term Bond ETF	10.72	49	IWN	iShares Russell 2000	4.56
20	IJH	iShares S&P MidCap 400	10.72	50	IVE	iShares S&P 500	4.51
21	XLE	Energy Select Sector SPDR	10.38	51	EWY	iShares MSCI South Korea	4.38
22	BND	Vanguard Total Bond Market	9.25	52	SHV	iShares Barclays Short TSY	4.16
23	DIA	SPDR Dow Jones Industrial	9.21	53	IWO	iShares Russell 2000	4.02
24	VNQ	Vanguard REIT ETF	8.58	54	XLU	Utilities Select Sector	3.91
25	HYG	iShares iBoxx High Yield	8.32	55	EPP	iShares MSCI Pacific ex-JP	3.80
26	XLF	Financial Select Sector SPDR	8.05	56	XLI	Industrial Select Sector	3.69
27	SHY	iShares Barclays 1 3	7.93	57	VO	Vanguard Mid-Cap ETF	3.66
28	CSJ	iShares Barclays 40546 Year	7.82	58	DBA	DB Agriculture Fund	3.59
29	IJR	iShares S&P SmallCap 600	7.38	59	IWS	iShares Russell Midcap	3.42
30	FXI	iShares FTSE China 25	7.25	60	IWV	iShares Russell 3000	3.42

Main advantages of ETFs

Investors

-- Diversification at an affordable price

-- Behave like index mutual funds but are more flexible

-- Limit orders, short-selling, options

-- Lower fees

-- Tax efficiency: lower turnover than MFs (no need to sell assets each time
      someone sells, less capital gains)

Professionals

-- Used for trading & hedging by pros (HF managers, traders)

-- Gain exposure to a sector or country easily

-- Proxies for market factors for explaining stock returns

20 most active US ETFs (as of Feb 2009)

TICKER	DESCRIPTION	AUM	AVG VOL (3m)	EX RATIO (bps)
SPY	0.1 SP500	93B	366M	8
EFA	MSCI Intl Eq	31B	36M	34
GLD	Gold 0.1 oz	21B	13M	NA
EEM	MSCI Emerging Mkts.	19B	100M	72
IVV	SP 500 I-Share	15B	7M	9
QQQQ	Nasdaq 100 Index 1/10	12B	150M	20
IWM	Russel 2000	10B	77M	20
IWF	Russel 1000 Growth	10B	8M	20
AGG	Bond ETF	9.5B	0.7 M	20
IWD	Russel 1000 Value	9.2B	7M	20
VTI	Vanguard MSCI 1300	9.2B	11M	71
DIA	Dow 30	8.9B	32M	14
TIP	Inflation-prot bonds	8.6B	0.7M	20
XLF	Financial SPDR	7.7B	200M	23
SHY	1-3 yr Treasurys	7.7B	1.3M	15
LQD	IG Corporates	6.9B	1.4M	15
MDY	Mid-Cap SPDR	6.8B	10M	25
FXI	China Xinghua 25	5.9B	43M	74
IWB	Russel 1000	5.7B	9M	15
EWJ	Japan	5.6B	32M	52

Sector ETFs

TICKER	DESCRIPTION	AUM ($B) *	VOL ($M)
XLF	Financial SPDR	7.7	177
XLE	Energy SPDR	4.4	40
OIH	Oil Services HLDR	5	11
XLK	Tech SPDR	1.8	8
IGE	Natural Resources	1.2	0.8
PHO	Water Resources	1.3	0.5
XLP	Consumer Staples	2.23	6.7
XLV	Health Care	2.06	6
XLU	Utilities	1.9	8
MOO	Agribusiness	0.6	0.5
GDX	Gold Miners	2.7	7.5
PPH	Pharmaceuticals	1.5	0.6
PBW	Clean Energy	0.6	0.8
IYR	Real Estate	1.66	37
BBH	Biotech HOLDRS	1.38	0.1
XLI	Industrials	1.1	12.1
SMH	Semiconductors	0.75	12
IYE	Energy Ishare	0.6	1.5
IBB	Biotechnology	na	0.9
IYW	Technology	0.6	0.3
XME	Metals & Mining	0.2	1.8
RTH	Retail	0.35	5
RKH	Regional Banks	0.3	2.5
IYT	Transportation	0.37	0.8
XLY	Consumer Discretionary	0.6	7

*Feb 2009

Country ETFs

TICKER	DESCRIPTION	AUM ($B)	VOL ($M)
EWZ	MSCI Brazil	3.5	20
EWJ	MSCI Japan	5.6	32
FXI	Xinghua 25	5.94	43
EWT	Taiwan	1.3	12
EWY	Korea	1.26	3.8
EWC	Canada	1	1.8
EWH	Hong Kong	1.1	5
EWS	Singapore	0.7	3
RSX	Russia	0.4	1.3
EWA	Australia	0.5	2.9
EWW	Mexico	0.5	3.2

Main categories of ETFs

- Trackers: industry sectors

- Trackers: country

- Currency: based on non-deliverable forwards (NDFs)

- Commodity: based on physical

- Commodity: based on rolling futures

- Actively managed

- Leveraged & inverse

ETFs as Risk-Factors?

$$I_1, I_2, ... I_n \qquad \text{reference ETFs}$$

$$\frac{\Delta S}{S} = \sum_{k=1}^{n} \beta_{sk} \frac{\Delta I_k}{I_k} + \varepsilon_s$$

-- Use sparse regression techniques to map stock to ETFs

-- Use stock's sector to match stock to ETF

-- In case of several ETFs per sector, use liquidity, highest R-squared

Evaluating the use of ETFs as factors in APT

In previous lectures, we found out how many eigenportfolios are needed approximately to explain the systematic portion of stock returns using panel data for stock returns.

We obtained a matrix of almost uncorrelated residuals for **m=15 or higher.**

Since eigenportfolios are not tradable (except perhaps for the first one), this leaves us with the identification problem for factors.

We perform an analysis of APT **using <u>sector ETFs</u> as factors**.

Three experiments:

* <u>Multiple regression</u> on 19 ETFs

* <u>Matching pursuit</u> on 19 ETFs

* Association of a <u>single ETF</u> to each stock

After removing mass at zero (19 etfs, MR)
(Red line=Marcenko-Pastur)

Lambda_max=11.9613
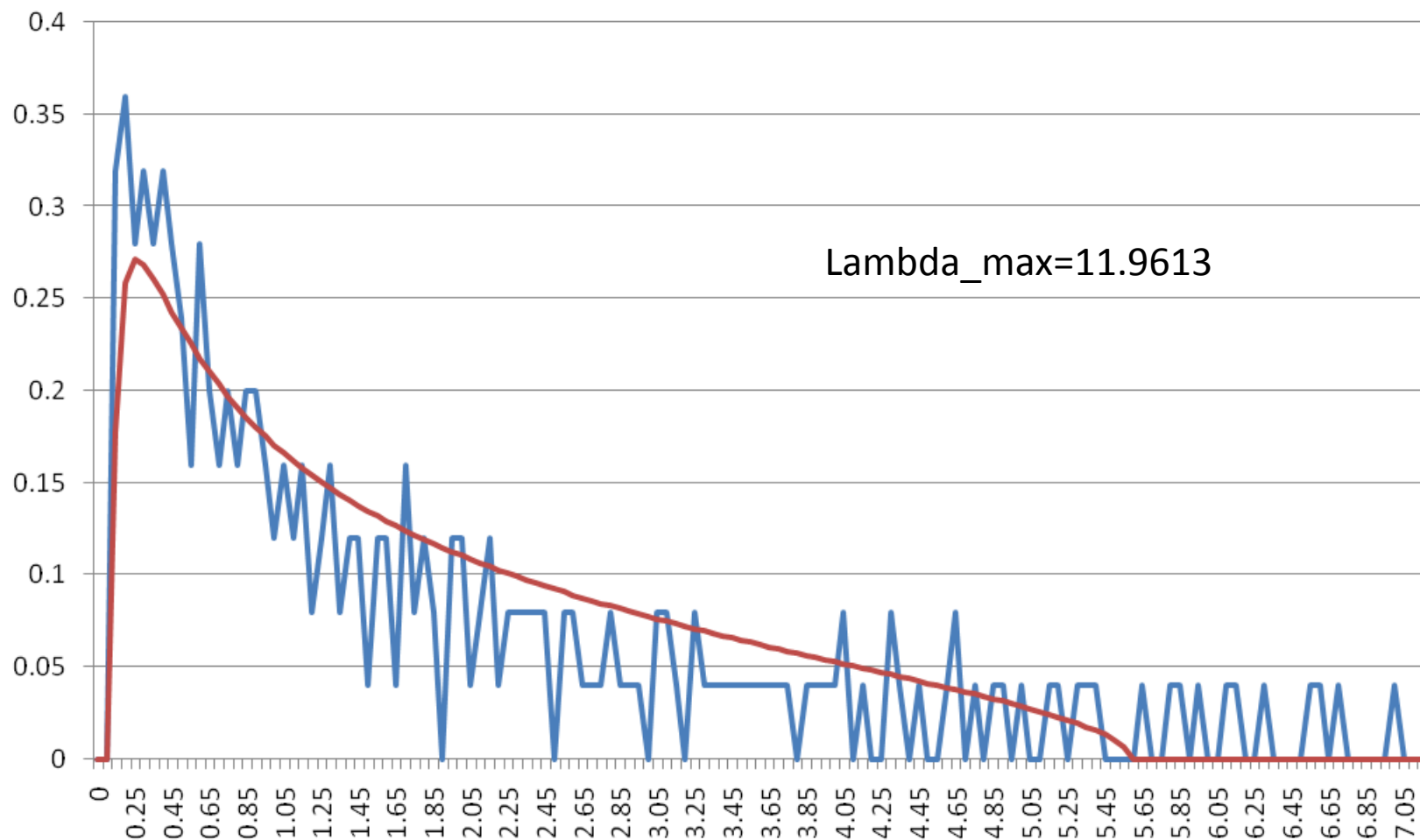
Noise Spectrum for Matching Pursuit Residuals

Lambda_max=12.02
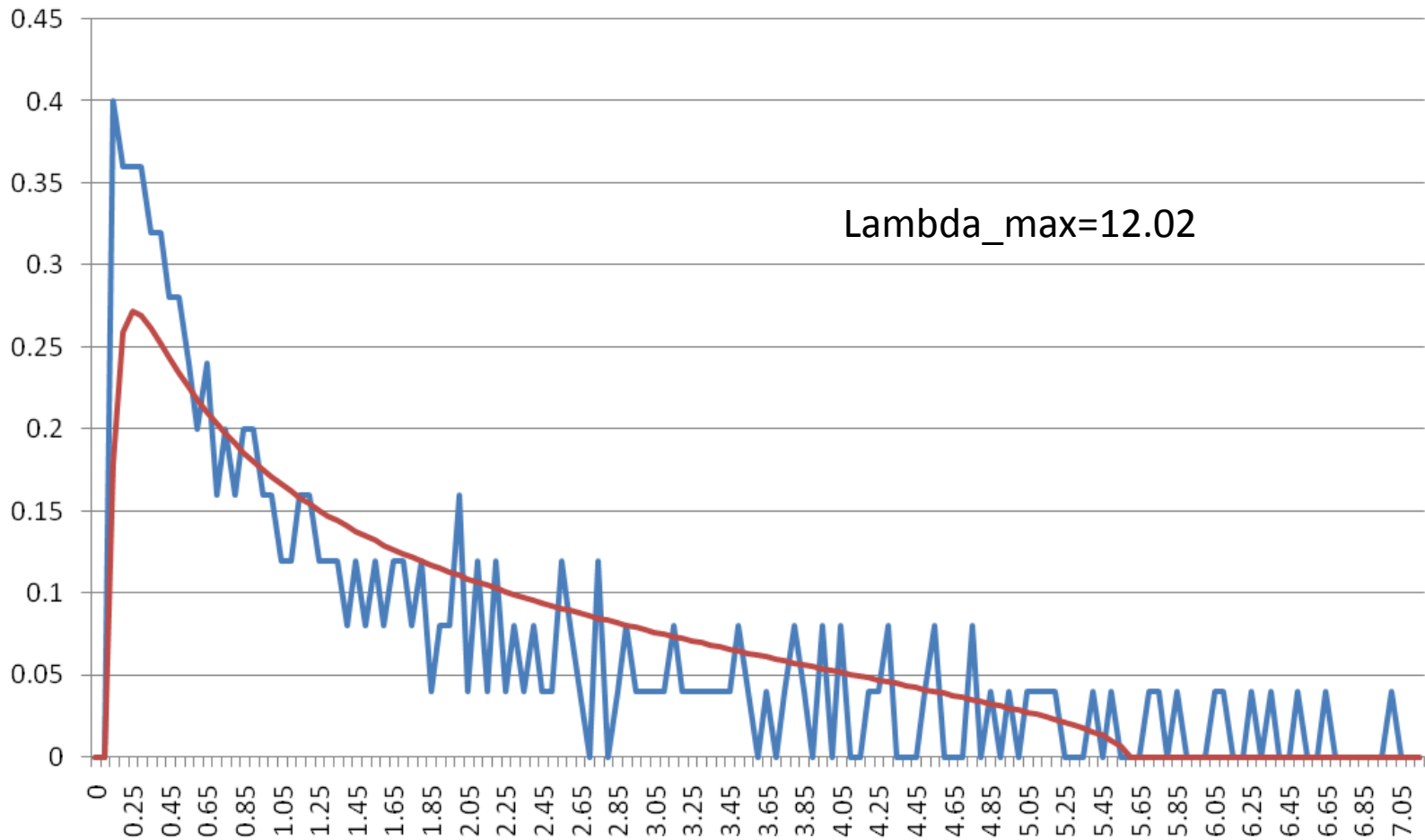
Density of States for Correlation matrix of residuals after removing a sector ETF associated with each stock

Lambda_max = 17.52
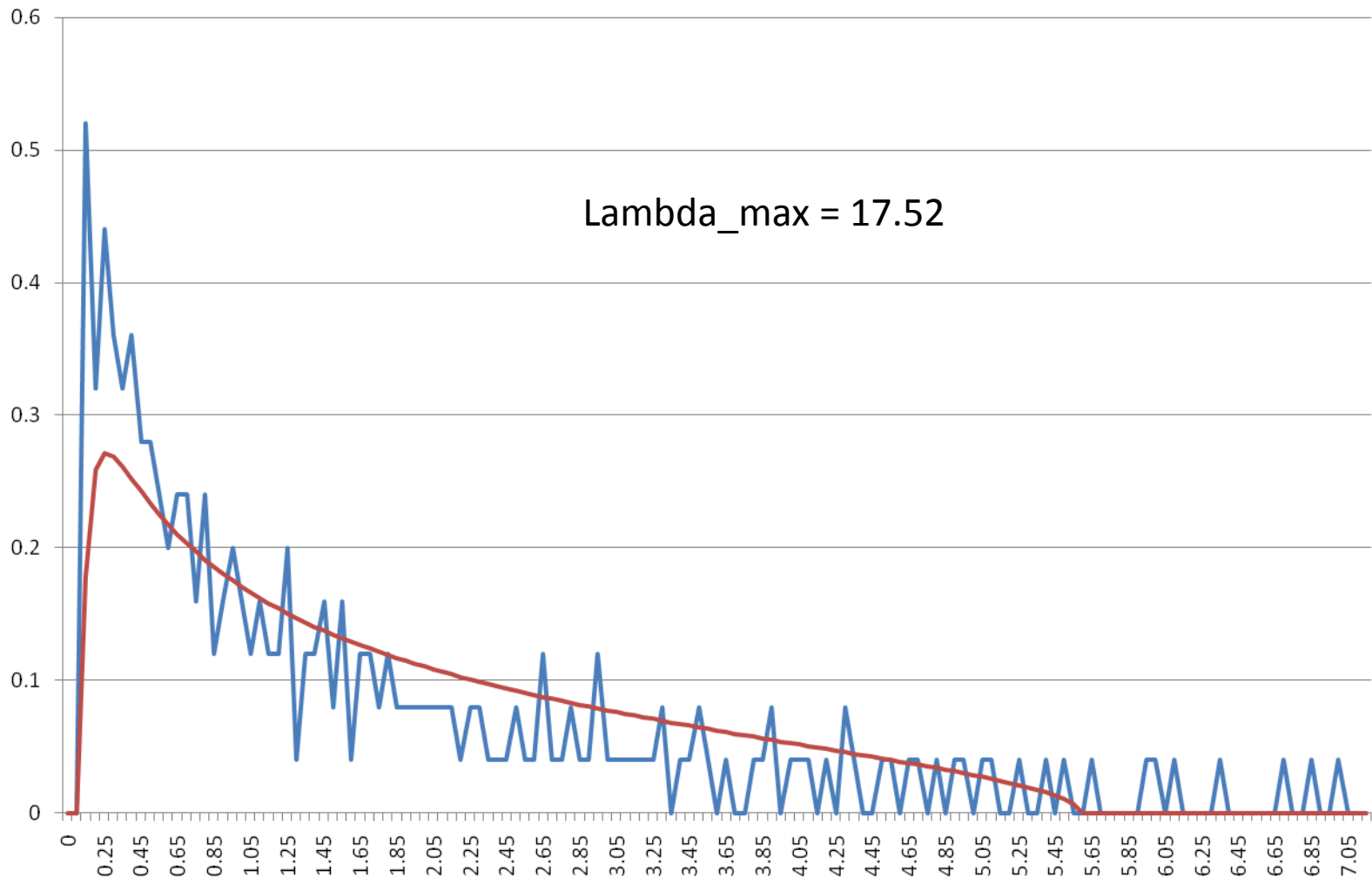
Marcenko Pastur compared to PCA residuals with m=30

$$\lambda_1 = 7.75$$

$$\frac{\lambda_1}{N} = \frac{7.75}{500} = 1.6\%$$

x
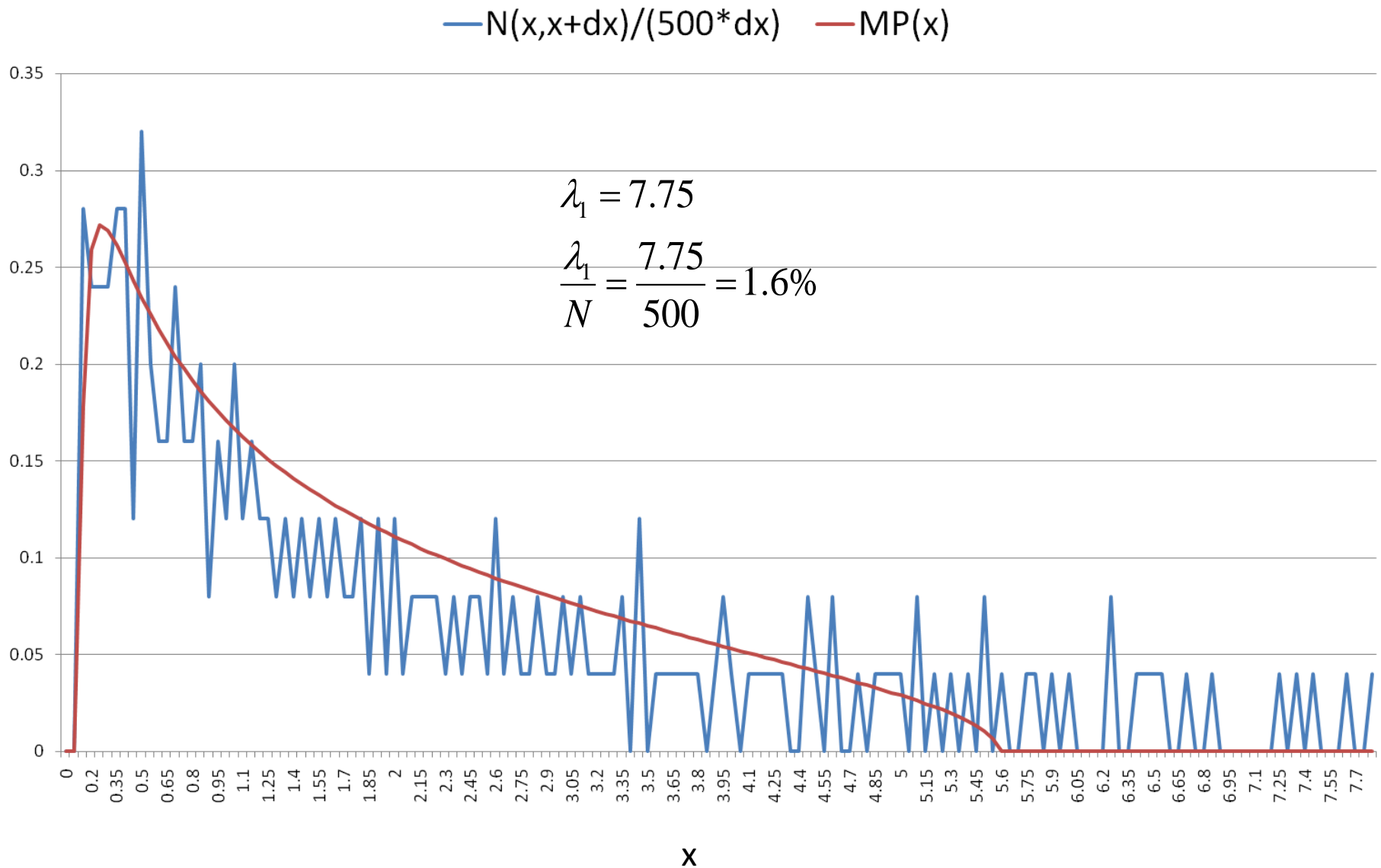
Explained variance, PCA

# PCA Factors	Eigenvalue	Explained variance
1	220.7666329	44.2%
2	19.71199871	48.1%
3	13.27441319	50.8%
4	10.77926533	52.9%
5	7.573853458	54.4%
6	7.154546677	55.9%
7	5.513055882	57.0%
8	4.481459251	57.9%
9	4.304371965	58.7%
10	3.752952769	59.5%
11	3.683214506	60.2%
12	3.551066783	60.9%
13	3.515707415	61.6%
14	3.306831309	62.3%
15	3.15796629	62.9%
16	3.077571455	63.5%
17	2.967642708	64.1%
18	2.928129277	64.7%
19	2.890882066	65.3%
20	2.730708854	65.8%
21	2.683363038	66.4%
22	2.6384565	66.9%
23	2.566737639	67.4%
24	2.539973119	67.9%
25	2.453768922	68.4%
26	2.411940173	68.9%
27	2.362115453	69.4%
28	2.315264274	69.8%
29	2.279548933	70.3%

Average correlation of residuals

	Lambda 1	avg. correlation
stock returns	220.76	44.2%
residuals, CAPM, m=1	33.6	6.7%
residuals, m=15	8	1.6%
residuals, m=30	7.75	1.6%
residuals, 19 etfs	12	2.4%
residuals, industry etf	17	3.4%

Going from m=15 to m=30 does not change correl. of residuals.

Residuals after industry ETF projection have half the correlation of CAPM residuals, but twice the correlation of the residuals with 15 factors.

The residual of a stock after projection on the corresponding industry ETF has approximately 55% less variance than the stock (not shown here)

Arbitrage of ETFs against the underlying basket

Stock N
*
*
*
*
Stock 3
Stock 2
Stock 1

←→

ETF
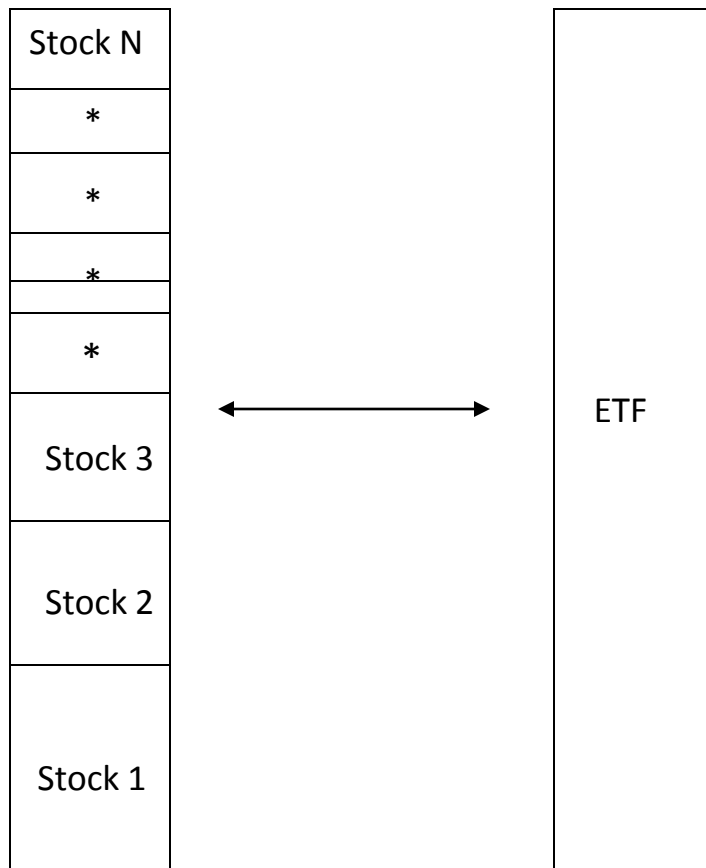
1. Buy/sell ETF
against the underlying share holdings

2. Creation/redemption of ETFs
to close the trade

This requires high-frequency algorithmic
trading to lock-in arbitrage opportunities

Often done with partial reconstruction, i.e.
basis risk

Commodity ETFs

Physical commodity: GLD (streetTracks Gold Shares)
                                   IAU (iShares Comex Gold Trust)

Futures-based: DGL (Powershares DB Gold Fund)

Futures-based ETFs are based on maintaining a
position in a constant-maturity futures by **rolling**
from one contract to the next as they reach maturity

This may result in underperformance with respect to
 the spot commodity for at least 3 reasons

-- fees

-- rolling costs (including front-running)

-- contango

Difference Between Gold bullion and Futures-based ETFs

DGL - DB Gold (AMEX) - Monthly Line Chart
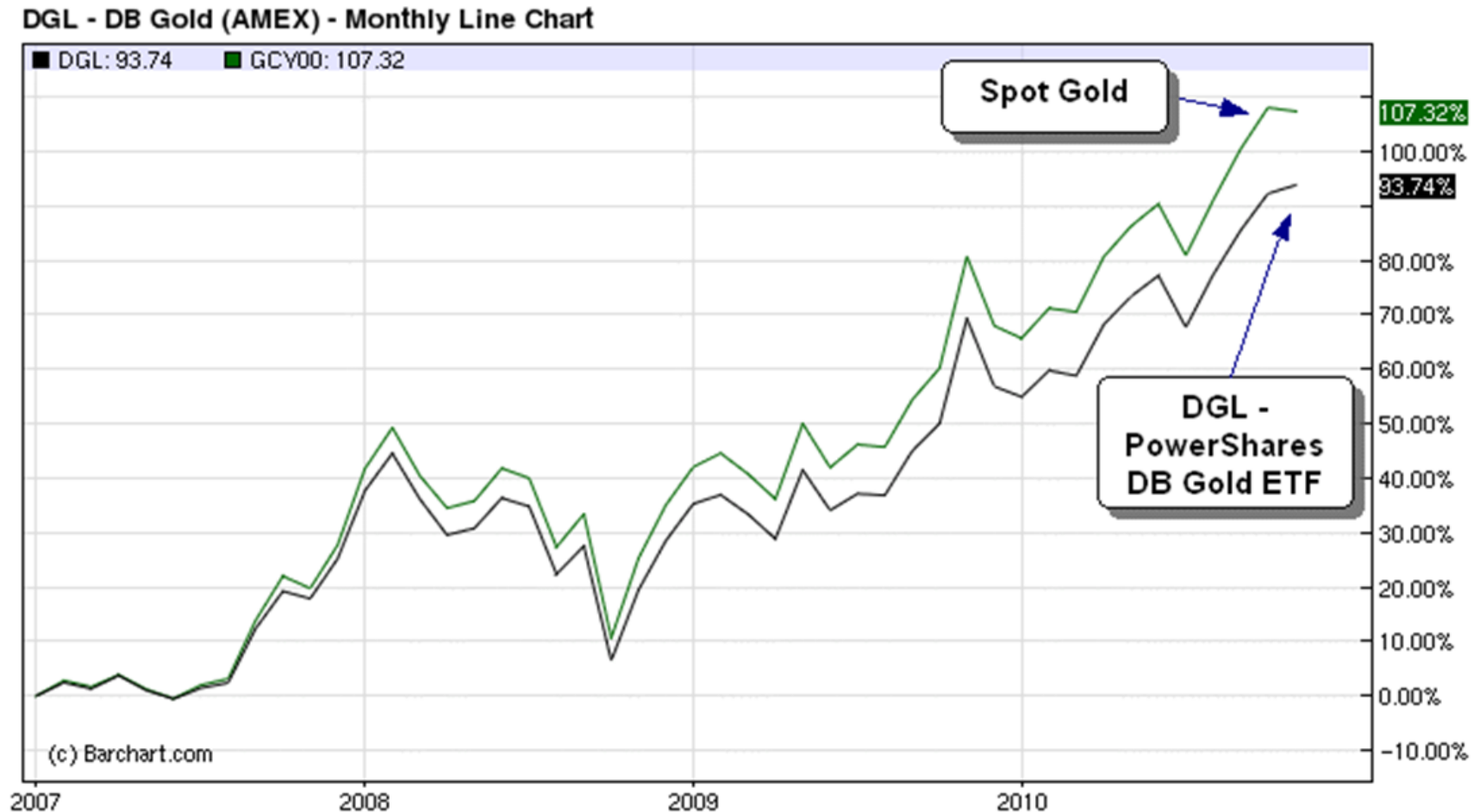
Growth of Gold ETFs over the last 6 years: the next bubble?
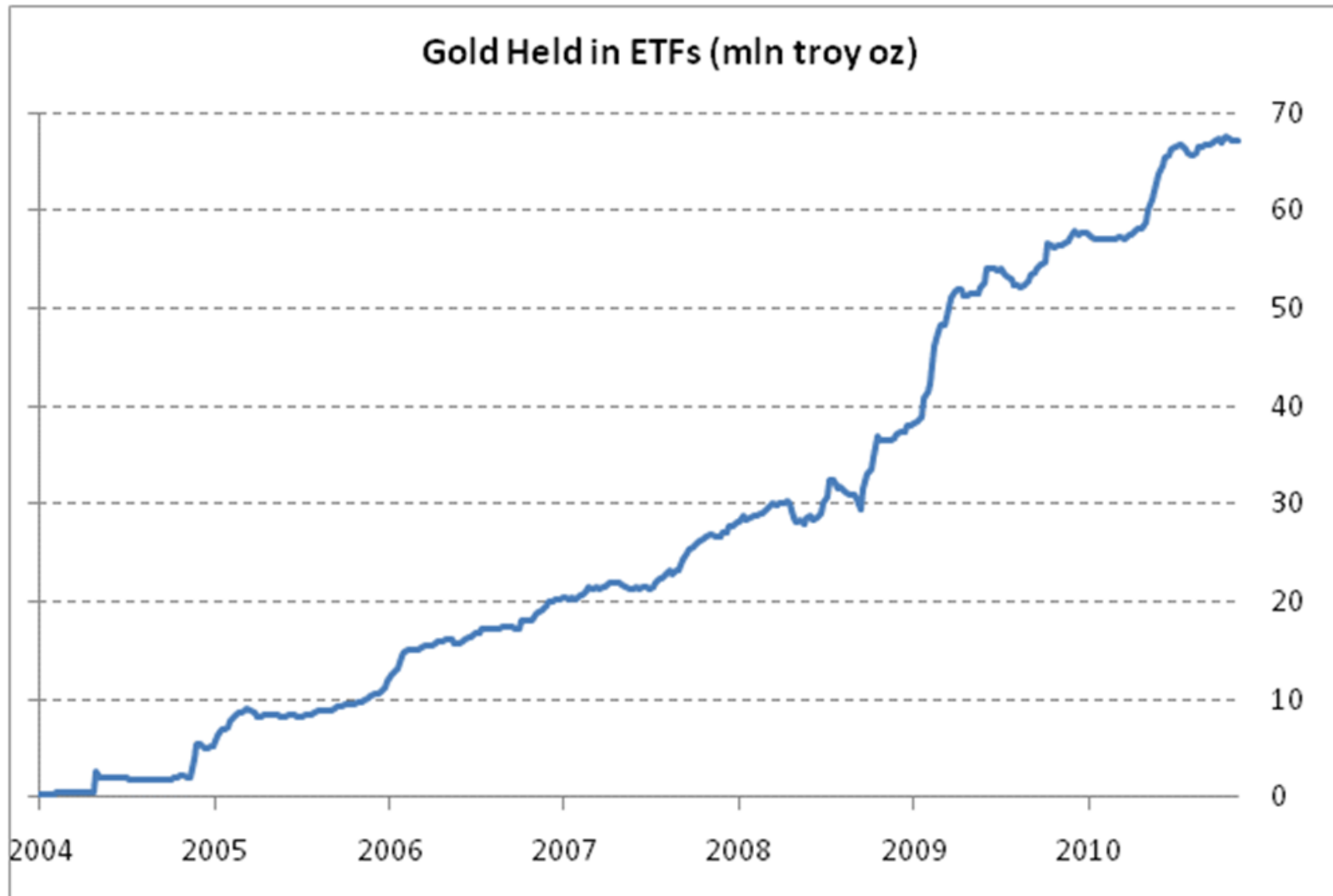
Commodity Futures: Contango
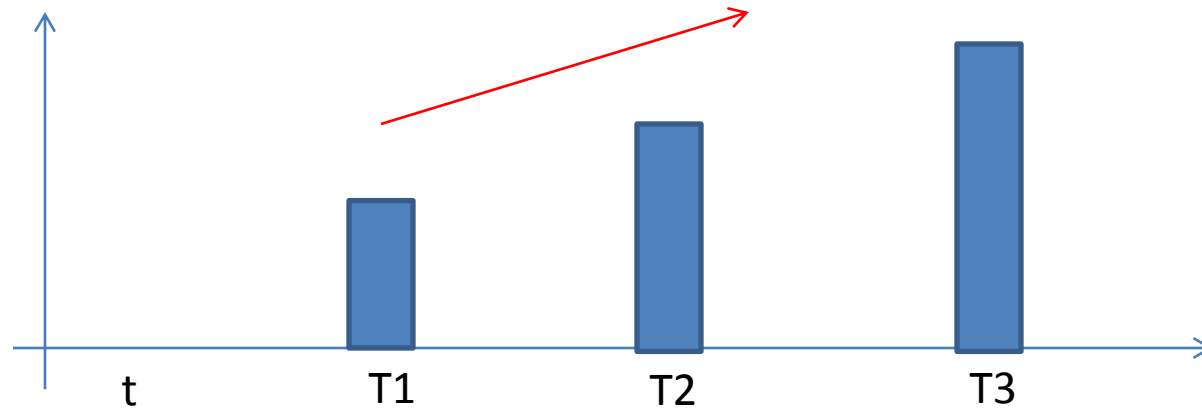
Futures are said to be in **contango** if the futures price increases
with the time-to-delivery (futures is higher than spot)

If the futures are in contango, this means that the ``convenience
yield'' is low and the cost of storing and financing make the
forward delivery more expensive as time goes by

Commodity Futures: Backwardation
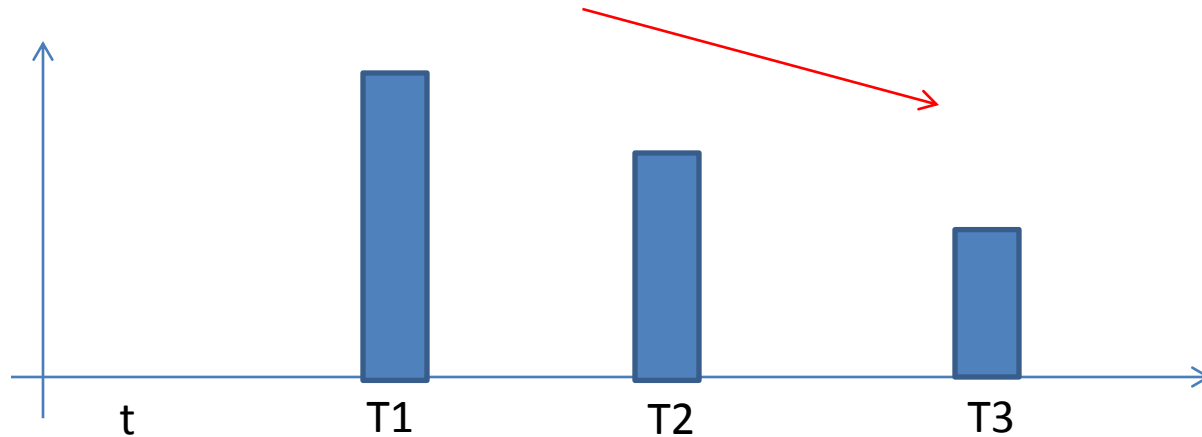
Futures are said to be in **backwardation** if the futures price decreases with the time-to-delivery (futures is lower than spot)

Associated with a high convenience yield. For example, rental for gold could be expensive, etc.

Futures-based ETFs: rolling

Mandate:

-- invest $$ in one or more contracts, aiming to carry a fixed-maturity

-- change contracts as expiration arrives

$$\frac{dI_t}{I_t} = a(t)\frac{dF_t^{(1)}}{F_t^{(1)}} + \left(1 - a(t)\right)\frac{dF_t^{(2)}}{F_t^{(2)}} + rdt$$

$$F_t^{(i)} = \text{futures with settlement date } T_i$$

Rolling with constant maturity τ

Discrete rolling (USO, UNG)

$$a(t) = \begin{cases} 1, & \text{if } t + \tau < \dfrac{1}{2}(T_1 + T_2) \\[2mm] 0, & \text{if } t + \tau \geq \dfrac{1}{2}(T_1 + T_2) \end{cases}$$

$t \qquad T_1 \qquad t+\tau \qquad T_2$

Continuous rolling (VXX, VXZ)

$$a(t) = \frac{T_2 - (t + \tau)}{T_2 - T_1}$$

Typically, tau > T2-T1

Contango implies futures have negative drift relative to spot

Simple model for F

$$F_t^{(i)} = S_t e^{(r_i - d_i)(T_i - t)} \qquad \text{contango} \Rightarrow r_i - d_i > 0$$

$S_t = \text{spot price}$

$r_i = \text{rate for expiration } T_i$

$d_i = \text{convenience yield - storage cost for mat.} T_i$

$$\frac{dF_t^{(i)}}{F_t^{(i)}} = \frac{dS_t}{S_t} - (r_i - d_i)dt,$$

In a low interest rate environment, contango means that convenience yields are negative. ($d_i < 0$)

Consequence for futures-based ETFs

$$\frac{dI_t}{I_t} = a(t)\frac{dF_t^{(1)}}{F_t^{(1)}} + \left(1 - a(t)\right)\frac{dF_t^{(2)}}{F_t^{(2)}} + rdt$$

$$= \frac{dS_t}{S_t} - [a(t)(r_1 - d_1) + (1 - a(t))(r_2 - d_2)]dt + rdt$$

$$= \frac{dS_t}{S_t} + [a(t)d_1 + (1 - a(t))d_2]dt$$

Negative drift relative to spot px.

Theory meets practice in the USO oil ETF

USO - United States Oil (AMEX) - Weekly Line Chart

United States Oil ETF (USO) vs Spot WTI Crude Oil

Spot WTI Crude Oil Prices

USO ETF substantially underperformed spot when crude oil futures were in steep contango

UNG: Natural Gas ETF

UNG - United States Natural Gas (AMEX) - Weekly Line Chart

UNG: −83.85   NGY0: −40.41

United States Natural Gas ETF (UNG) vs Spot Natural Gas

Spot Natural Gas Prices

UNG ETF substantially underperformed spot due to natural gas being in a contango market

(c) Barchart.com

−40.41%
−83.85%

Long-Short Physical vs. Futures ETF

Since futures-based ETFs underperform spot, we should be able to profit (theoretically, at least) from going long physical ETF and shorting the futures-based etf on the same commodity.

Case study:

Physical ETF: GLD
Futures-based: DGL

$$X_t = \text{return of GLD}$$

$$Y_t = \text{return of DGL}$$

$$\frac{\Delta P_t}{P_t} = X_t - Y_t + r_s \Delta t \quad \therefore \quad P_T = P_0 \prod_{t=1}^{T} \left(1 + X_t - Y_t + r_s \Delta t\right)$$

First backtesting (no special rates)

Long 100% DLG, short 100% GDL, daily rebalancing

Theoretical performance: 1.8% per year (daily compounding)
3.3% volatility per year

Straight line suggests that the difference should correspond to financing costs

Backtesting with short borrowing costs

Assume that GLD can be financed at general collateral (e.g. 0.25%), so the Issue is how much does is cost to short DGL.

DGL short rate= **-2.381%**   (from large broker, March 23, 2011). This is a negative rate: you pay on cash balances.

Long 100% DLG, short 100% GDL, daily rebalancing, with short rate

Not a real arbitrage opportunity!

ETFs based on VIX

VIX = CBOE Volatility Index

VIX Futures = Futures contracts with monthly expirations settling on spot VIX.

VIX (and <u>index</u> option volatility) is generally in contango
Intuitively, option volatility is higher for longer maturities unless the market is very stressed.
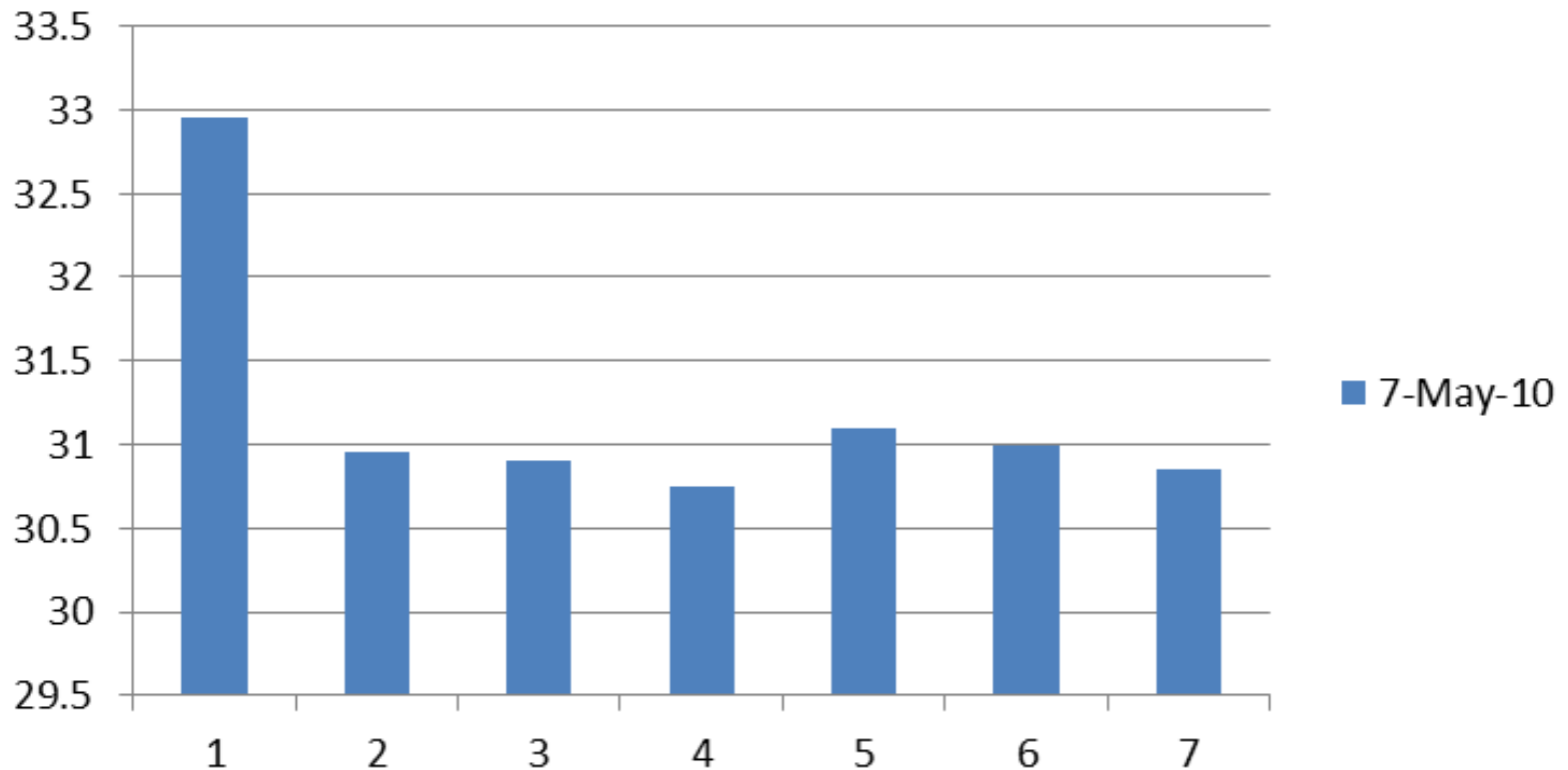
VIX and VIX Futures (March 22, 2011)

VIX is in contango (this is the general form of the VIX futures curve)

Stressed Volatility Market... backwardation

Months to settlement

Flash Crash (May 2010)
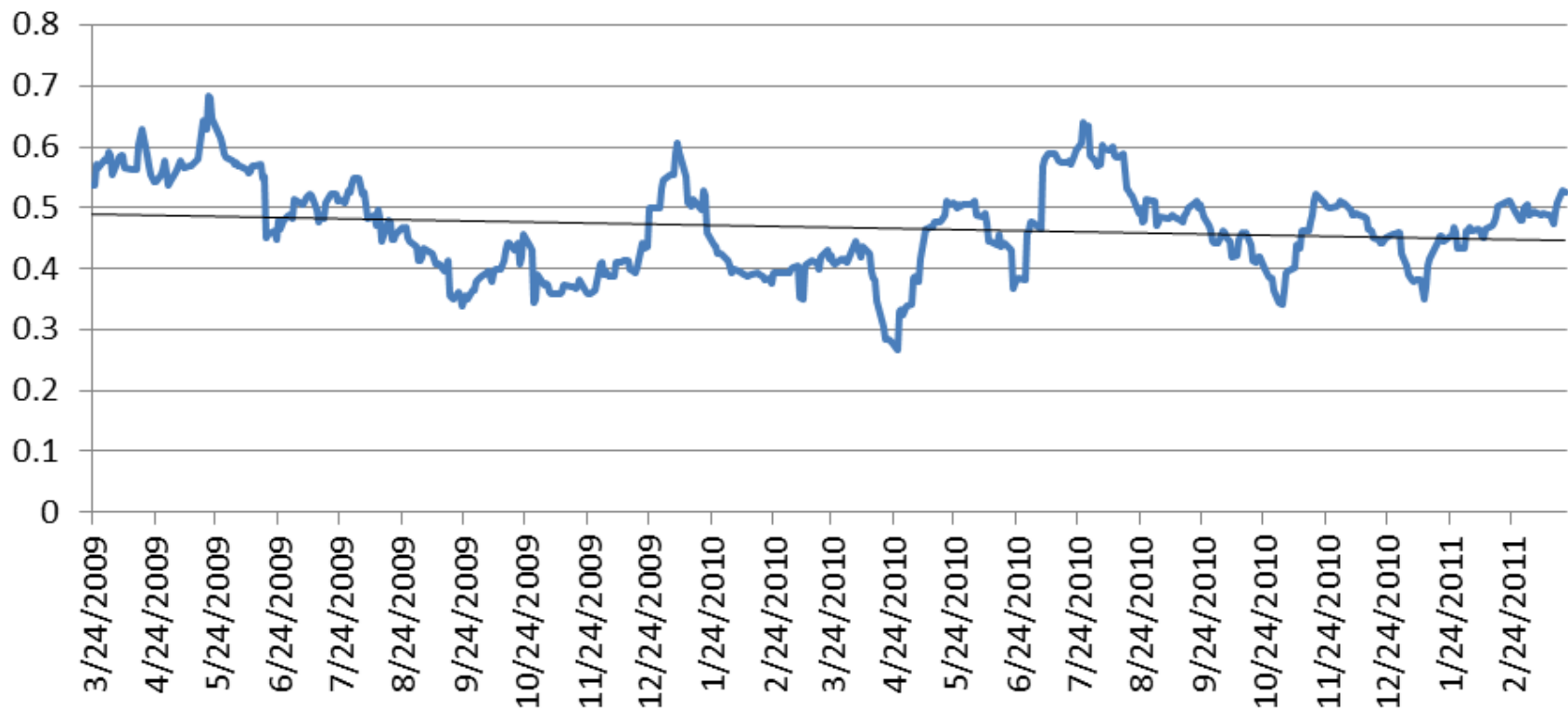
The VXX and VXZ ETNs

VXX: iShares ETN which tracks short term VIX futures (months 1 and 2)
      target maturity 30 days; continuous roll

VXZ: iShares ETN, tracks mid-term VIX futures (months 4 through 7);
      target maturity 120 days; continuous roll

Both securities have negative drift and are correlated to the same underlying asset. This gives rise to the possibility of arbitrage by building a long-short position

Connecting the volatilities of both products empirically

20-day regression coeff of daily returns: VXZ/VXX

Long-Short portfolio of VXX and VXZ

$X_t = $ daily return of VXX

$Y_t = $ daily return of VXZ

$Y_t = \beta X_t + \varepsilon_t, \ \beta = 0.5$
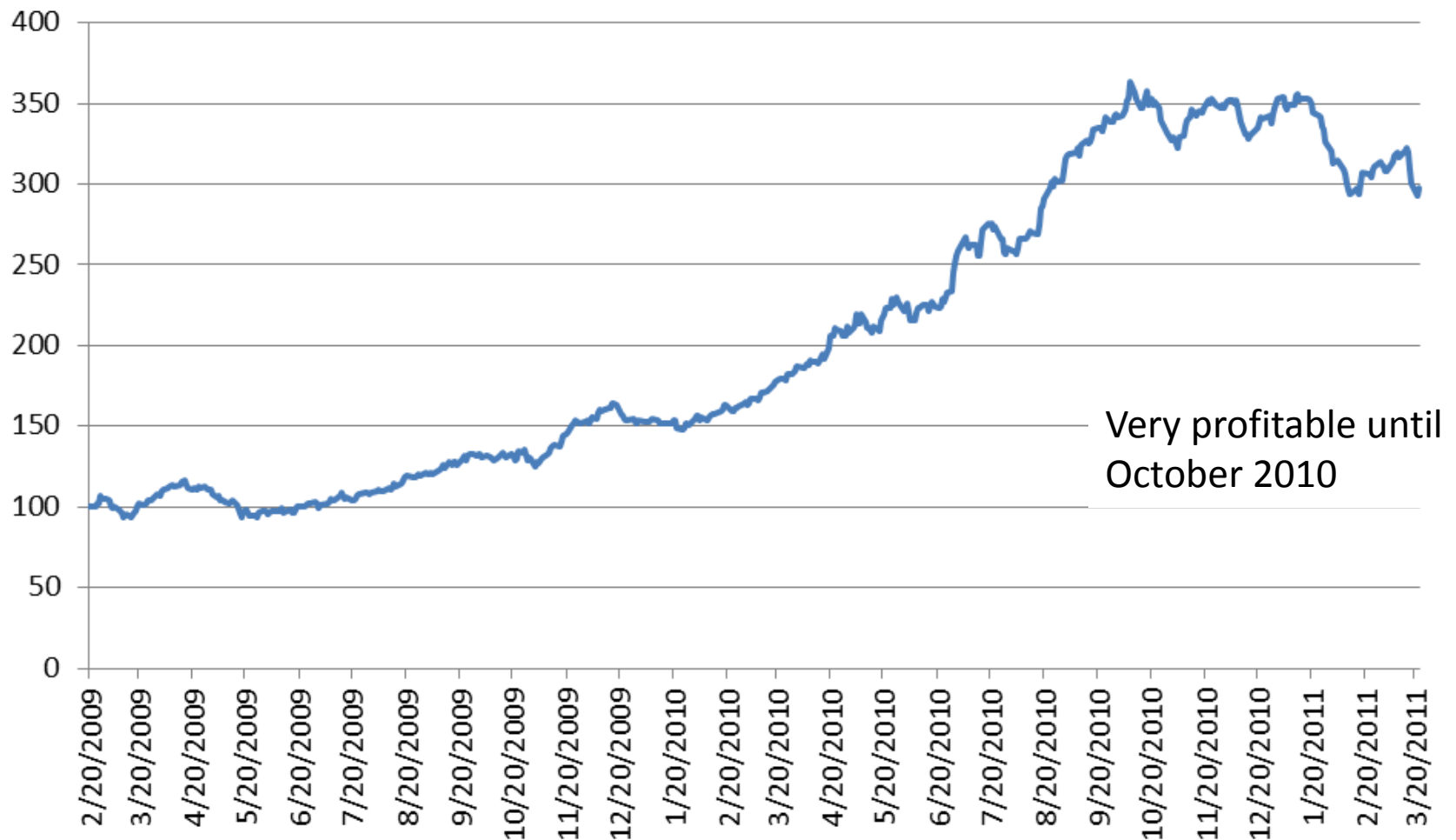
Long - short portfolio :

sell $1 of VXX, buy $2 of VXZ

$$PnL = \prod_{t=1}^{T}(1 - X_t + 2Y_t - r\Delta t + r_s\Delta t)$$
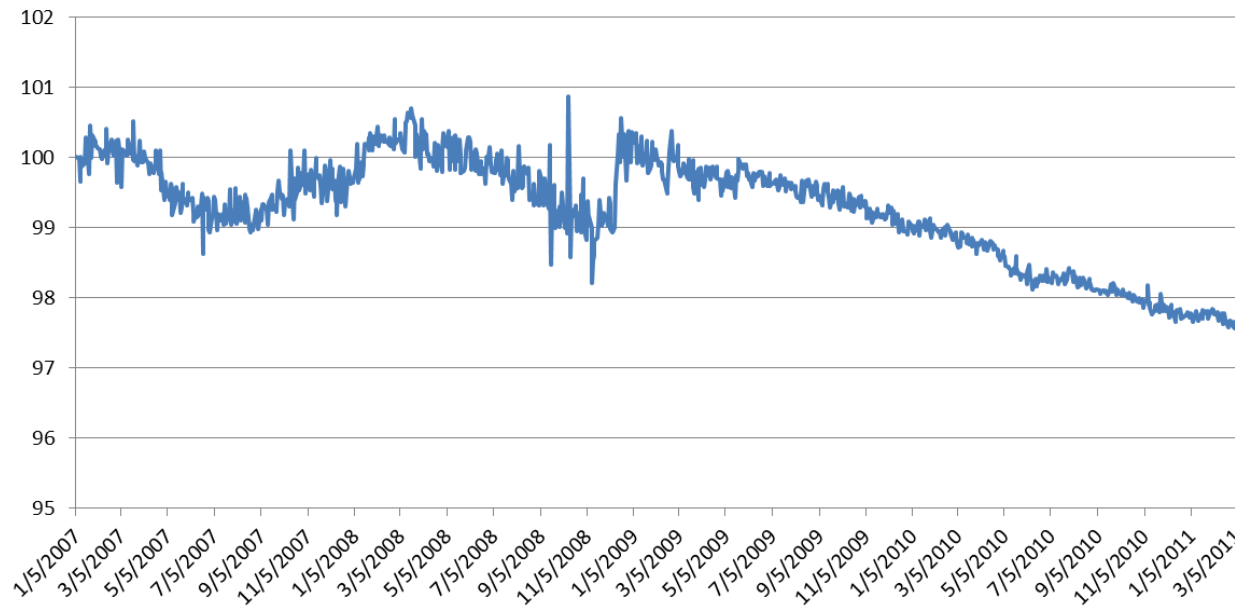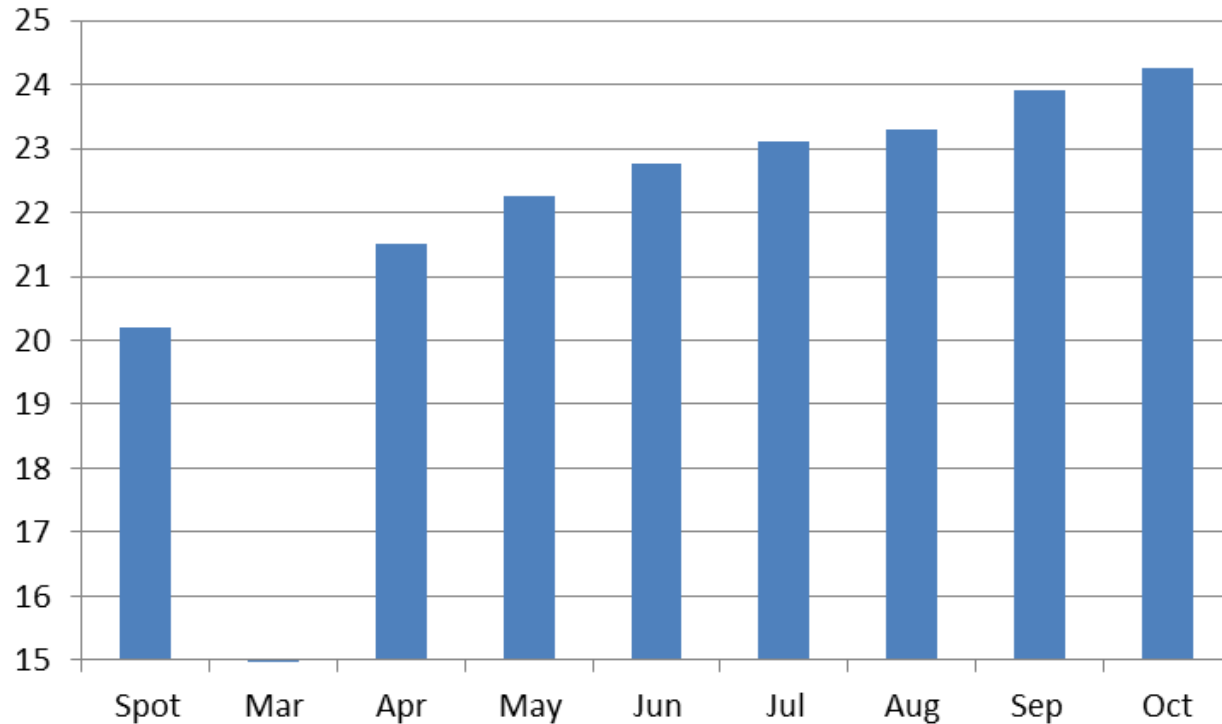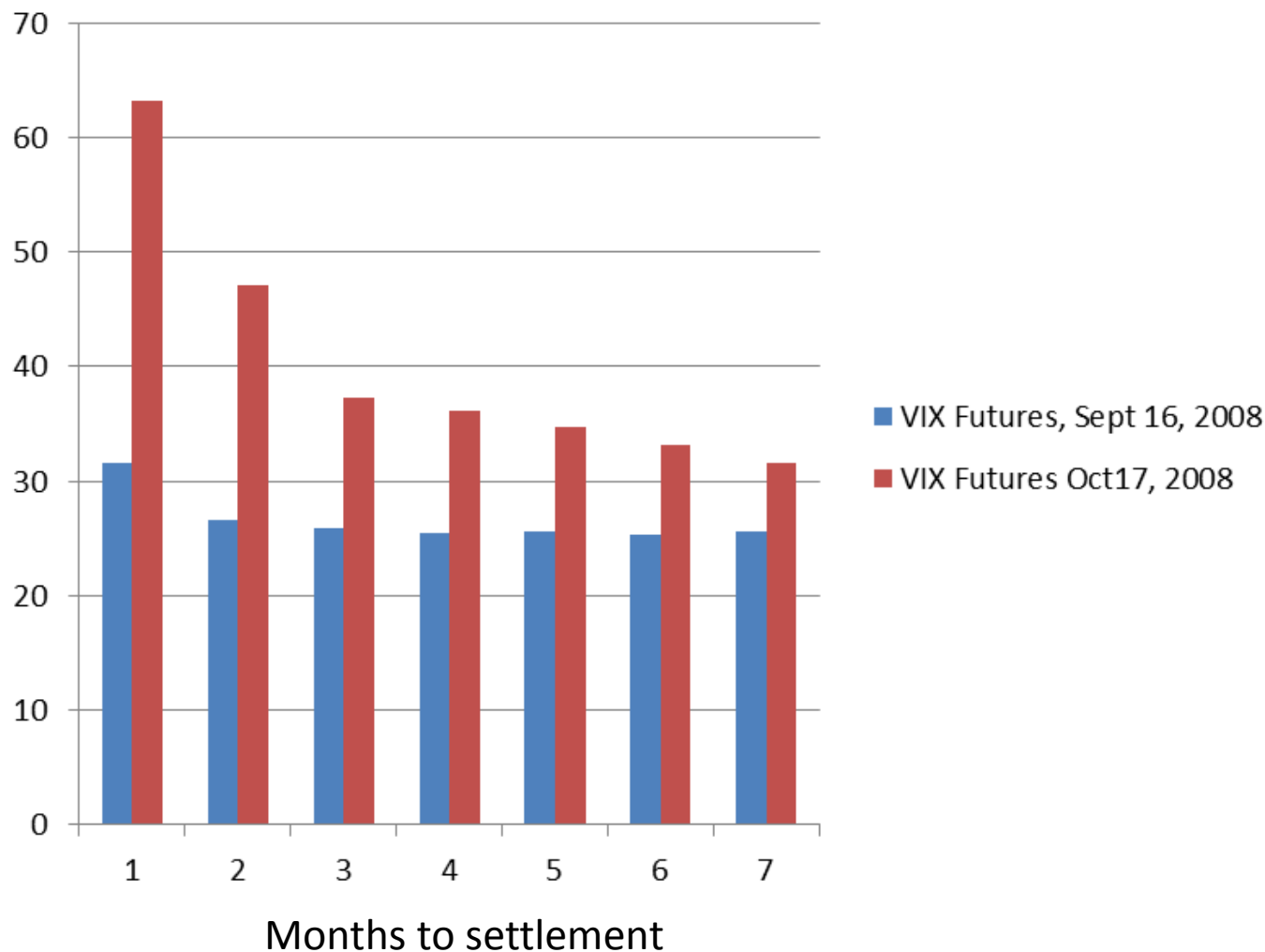
R_s (VXX)=-2.505% at present

Short the front-month ETN, long the back-month × 2 (since inception)

short 100% of VXX, long 200% of VXZ

Very profitable until October 2010

XVIX : Marketing the Volatility Contango

The VIX futures curve is often far steeper in the near-term than in the far-term.
As investors look to diversify their investment portfolios, money has poured into products
that offer access to short-term VIX futures contracts, driving up contract prices significantly
and further steepening the shorter end of the curve.

The **UBS E-TRACS Daily Long-Short VIX ETN (UBS XVIX)** offers sophisticated investors:

•The opportunity to capitalize on the steepness of the short end of the VIX futures curve

•A strategy that is historically uncorrelated to stock market returns

•Convenience of an exchange-traded security

The UBS E-TRACS Daily Long-Short VIX ETN is linked to the performance of the S&P 500 VIX Futures
Term-Structure Index Excess Return (Ticker: SPVXTSER). The Underlying Index is a composite
index that measures the return from taking a long 100% position in the S&P 500 VIX Mid-Term Futures™
Index Excess Return (the "Mid-Term Index") with a short, or inverse, 50% position in the S&P 500 VIX
Short-Term Futures™ Index Excess Return (the "Short-Term Index" together with the Mid-Term Index,
the "Sub-Indices"), with daily rebalancing of the long and short positions.
The performance of the Underlying Index is reduced by the Fee Amount of 0.85% per annum,
and increased by the Financing Payment.

Long/Short Portfolio vs. XVIX since inception