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Workshop on Central Clearing of Derivatives & Risk Management

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Post-Lehman: Clearing OTC Derivatives

- The financial crisis of 2007-2008 brought attention to systemic risk in world financial markets.

- One of the main concerns was the unregulated market in OTC derivatives

- Credit derivatives were at the center of the collapse of Lehman Brothers, Bear Stearns Co. and the government bailout of AIG and mortgage banks (GSEs).

- Aside from a general overhaul of banking regulations, the derivatives markets attracted the attention of regulators worldwide.

- The idea that OTC derivatives could be centrally cleared took root in the Fall of 2008 under the auspices of the NY Fed and Timothy Geithner, who went on to become the U.S. Treasury Secretary under the new Obama Administration.

- This led to a focus on the idea of Central Clearing of derivatives, following the model practiced by securities markets.

What is a CCP and what is it good for?

- Central Clearing is a legal/market framework which is often put in place to protect the market against systemic risk

- Clearinghouses are in charge of payments, settlement and clearing (registering) trades in a centralized location. This allows, for instance, regulators and investors to have a better picture of the market and to eliminate credit risk.

- In a bilateral transaction A and B make a trade. If this transaction is not fully paid (e.g. the security is bought on credit) then this creates a credit exposure between the counterparties.

- Short-selling equities requires lending/borrowing. All short selling necessarily introduces a credit exposure.

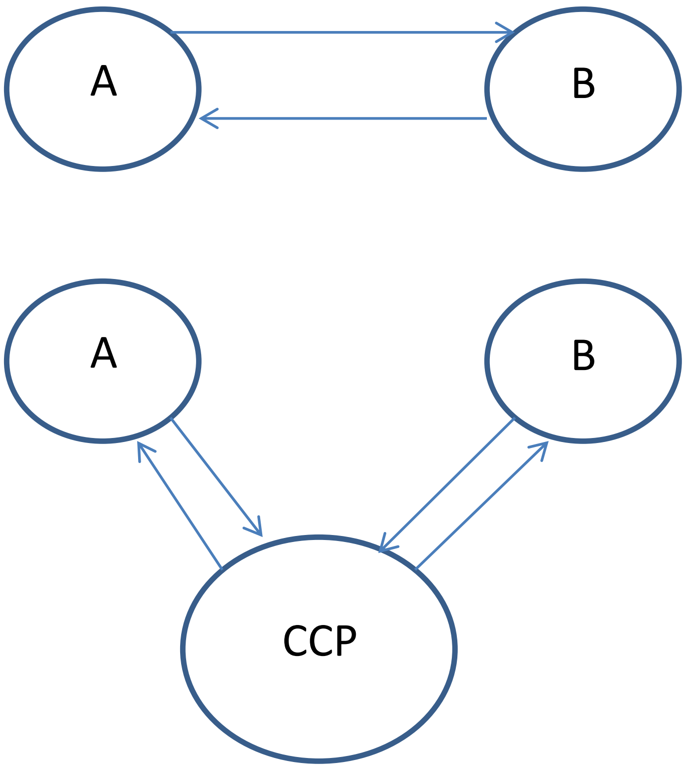
- Repurchase agreements are the standard way to finance fixed-income securities. Repos clearly introduce credit exposure.

Why the interest in CCPs now?

- CCPs have been used in the context of exchange-traded securities and futures for many years.
- The 2008 crisis and the bankruptcy of AIG was seen as being exacerbated by the proliferation of Credit Default Swap transactions. These transactions were over-the-counter and bilateral. Notional amounts were in the trillions USD.
- If a swap dealer cannot fund his positions, he must unwind them, producing a ``chain reaction'' in the system (like AIG).
- The idea of creating CCPs for over-the-counter derivatives originated in late 2008 and was made more concrete in the Dodd-Frank legislation of 2009.
- International norms were proposed by the Bank of International Settlements in 2010-2012 in a series of documents.
- The push for central clearing of derivatives became fully international since 2012.

Novation

- CCPs stand as counterparties to transactions between market participants, through a legal arrangement called novation.

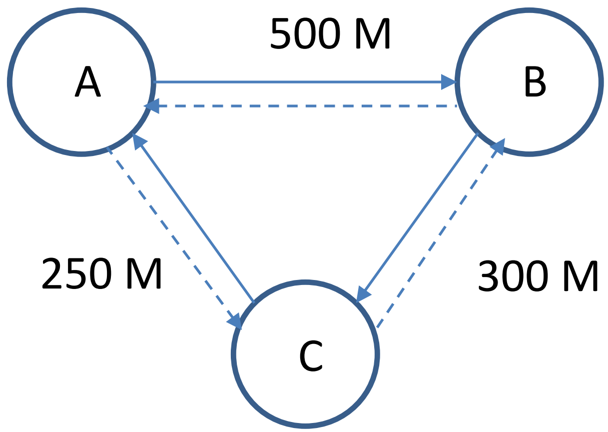


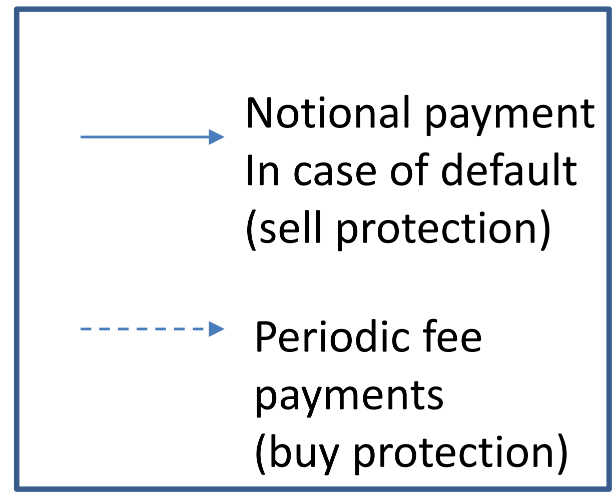
Before novation (bilateral trade between banks or bank and end-user)

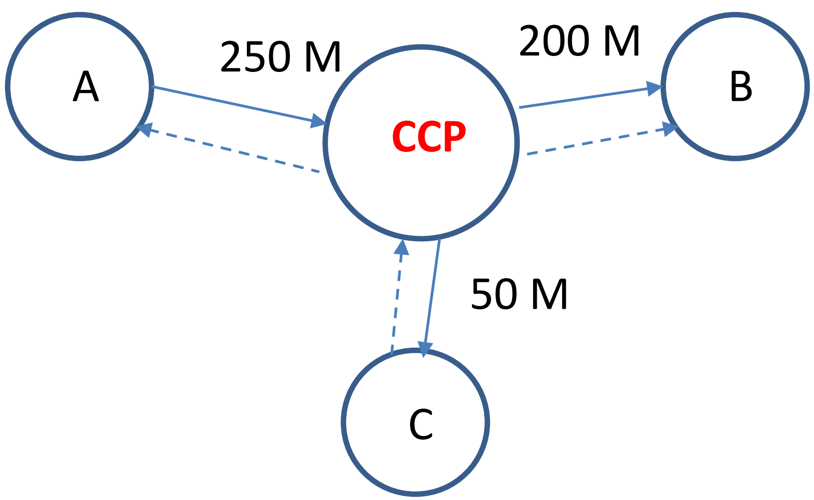
After novation

Novation replaces the credit risk between CPs to credit exposure to the CCP.

Netting







Novation + Netting implies ``compression''

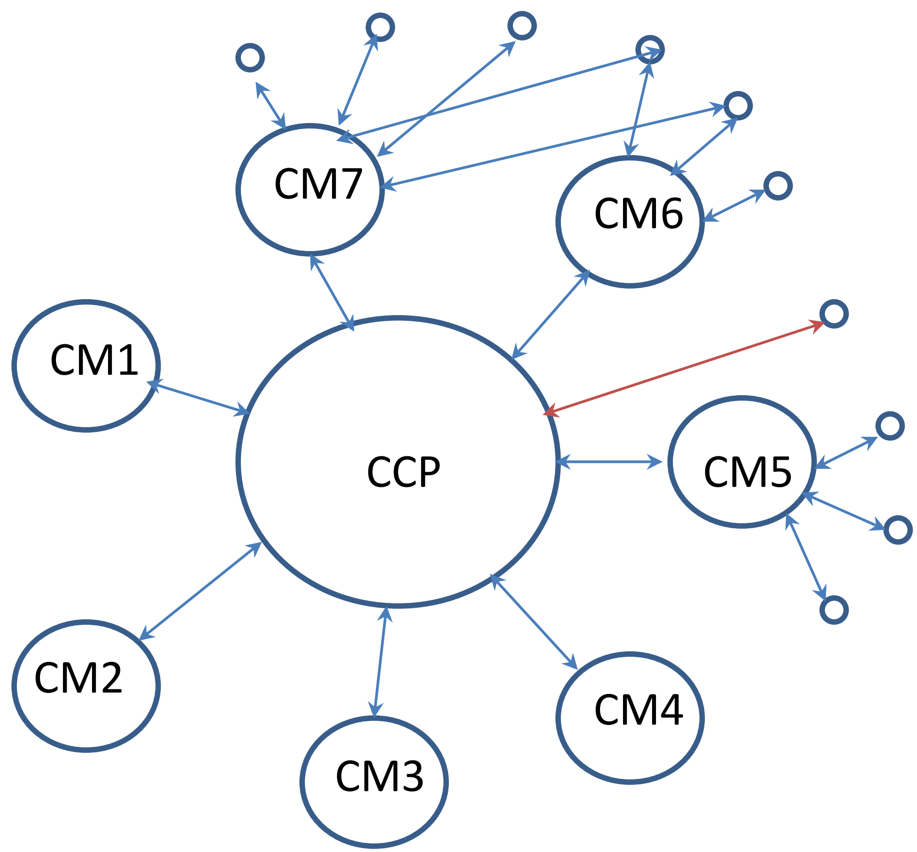
Central Clearing : transparency, Compression, mitigation of Systemic risk

Central clearing as a financial network

Clearing members:
large banks, BDs

Arrows represent
credit exposure

Small circles:
non-clearing market participants
(e.g., hedge funds,
asset-managers,
derivatives end-users,
clients of CPs,
retail investors)



Central clearing is a specific type of ``financial network'' as in Hamini, Cont & Minca (2010)

Tools for Risk Management of CCPs

- Initial Margin is collected from CPs to cover extreme but plausible market shocks

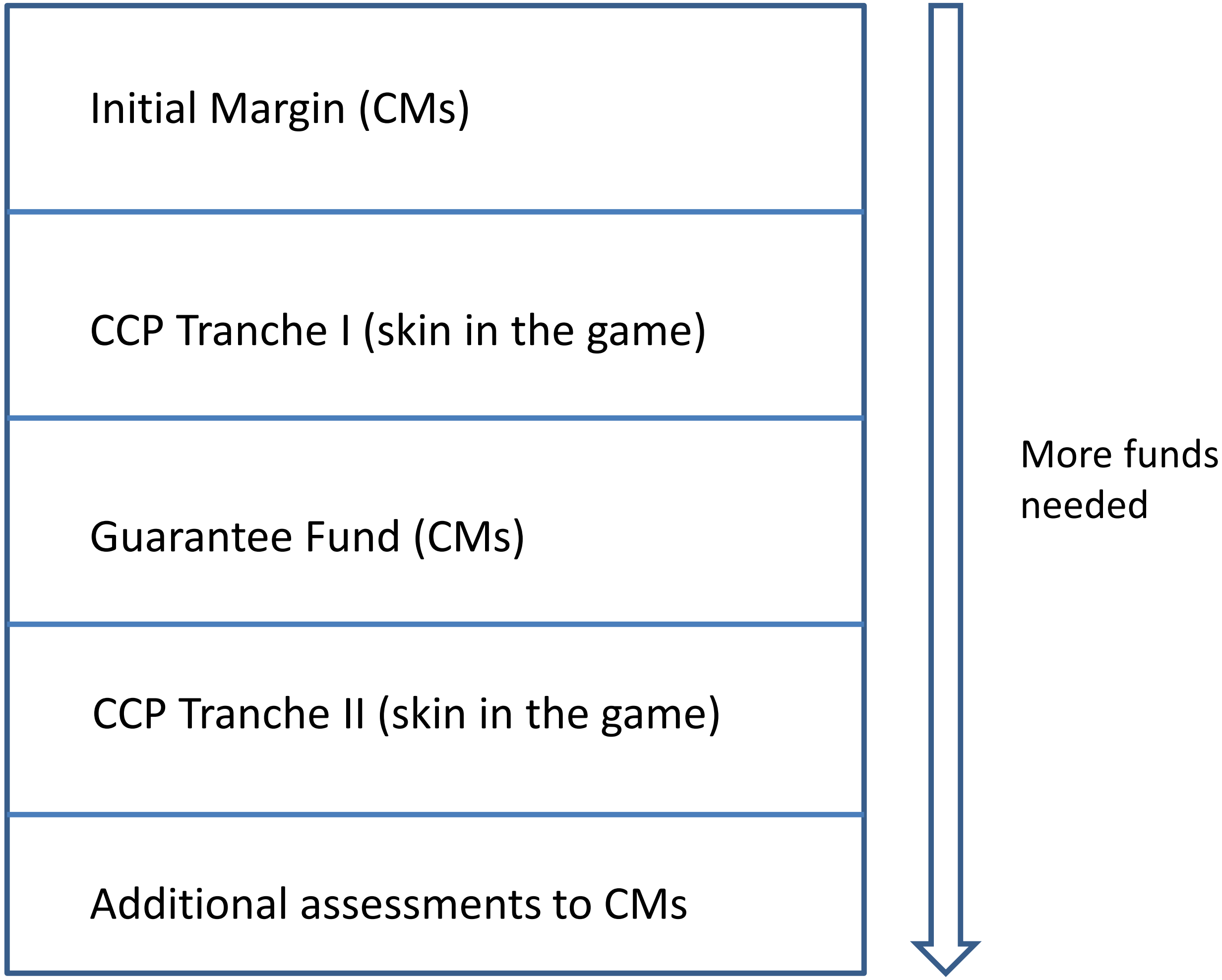
- Fund for mutualization of losses (``Guarantee Fund''), covering shortfall beyond the IM

- ``Loss tranches'' which can be used to cover mutualized losses with CCP's own capital (Skin in the game)

BIS, Principles for Financial Markets Infrastructures, BIS CPSS-IOSCO Consultative Report, April 2012

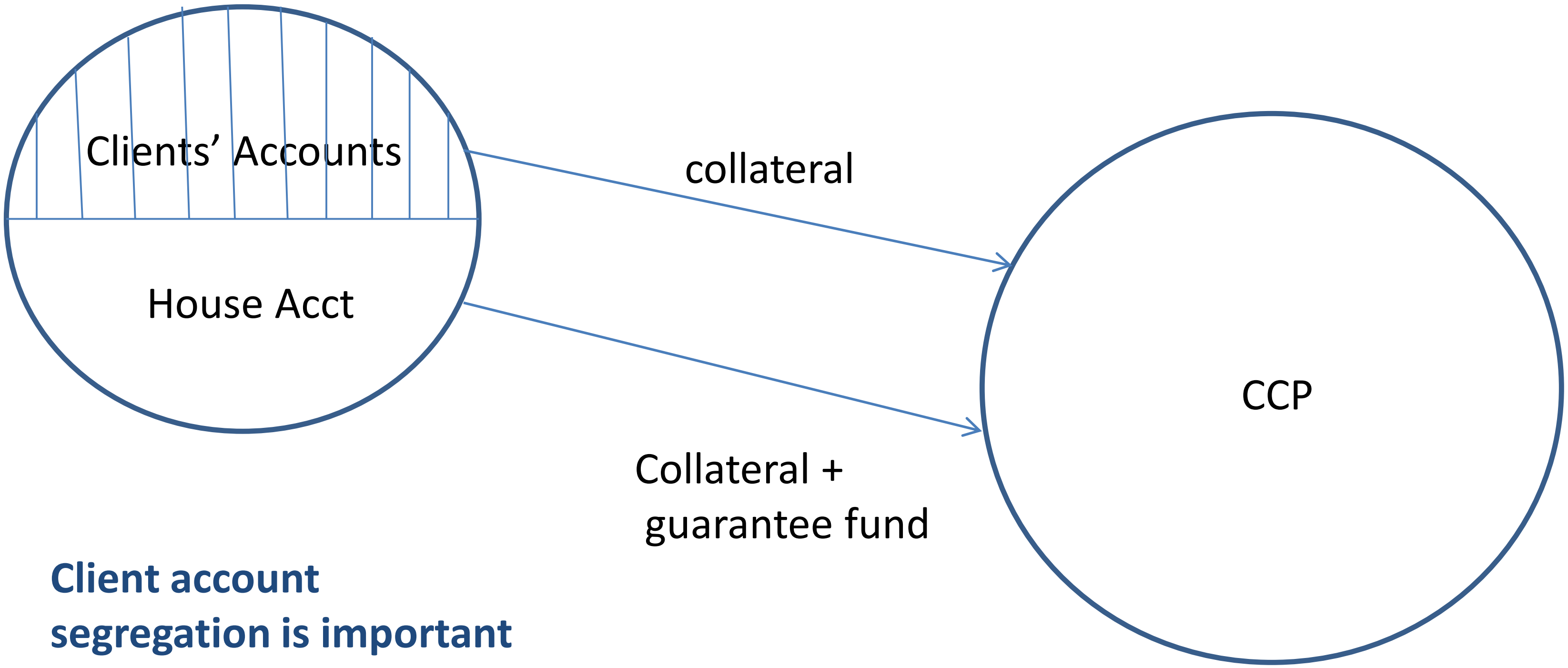
ESMA, Final Report, Technical Standards on OTC Derivatives, CCPs and Trade Repositories (``EMIR''), September 2012

Theoretical Risk Waterfall



Laws, in different countries, protect collateral in case of bankruptcy of a Clearing Participant.

Client/House Account



Client account segregation is important

Typically, each clearing member holds two accounts: the House account and the Clients' account. Both are margined separately.

Client's securities can be <u>``in street name'' </u>(held under CPs name) or in the Name of the <u>Ultimate Beneficiary.</u>

Client Clearing (EMIR)

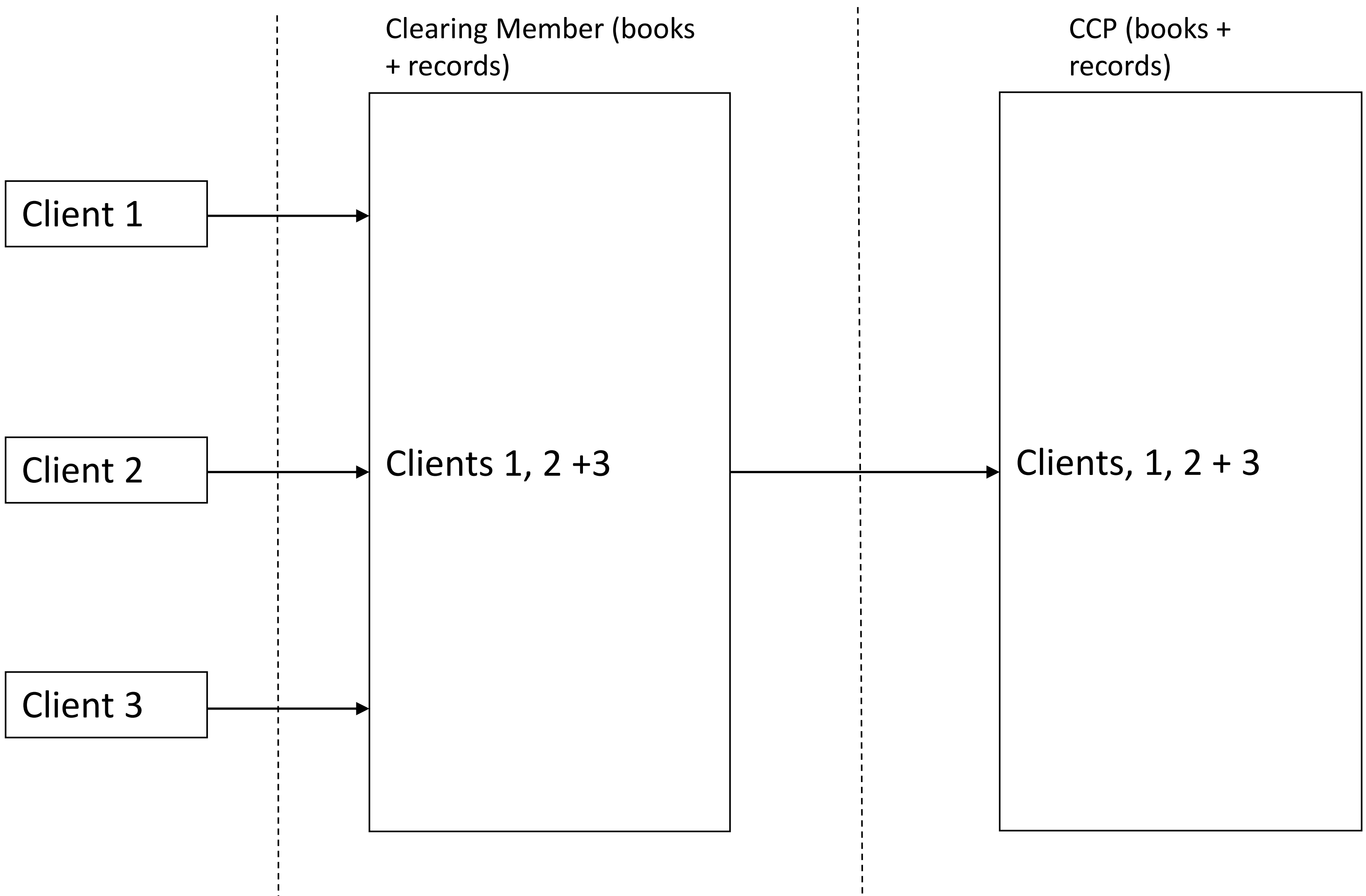
- CCPs and clearing members must offer both:
  - Omnibus client segregation: Separate records / accounts distinguishing between clearing member's assets and positions and assets and positions of its clients
  - Individual client segregation: Separate records / accounts distinguishing between assets and positions of each client of clearing member and any excess margin posted to CCP

- CCPs must allow clearing members to open further accounts
- Requirement to distinguish involves recording in separate accounts, not netting across accounts and not exposing assets in one account to losses in another

- CCPs and clearing members must disclose levels of protection and costs - must be reasonable commercial terms
- CCPs must commit to trigger procedure for **porting** - if clearing member defaults and client requests, transfer client positions and assets to another clearing member that has agreed to step in - omnibus and individual accounts
- **CCPs can actively manage their risks** by liquidating positions and assets if this cannot be done within a pre-defined timeframe

- Client collateral can only be used to cover positions held for relevant client account and any surplus on a clearing member default should be returned to client or, if not possible, to clearing member for relevant client account

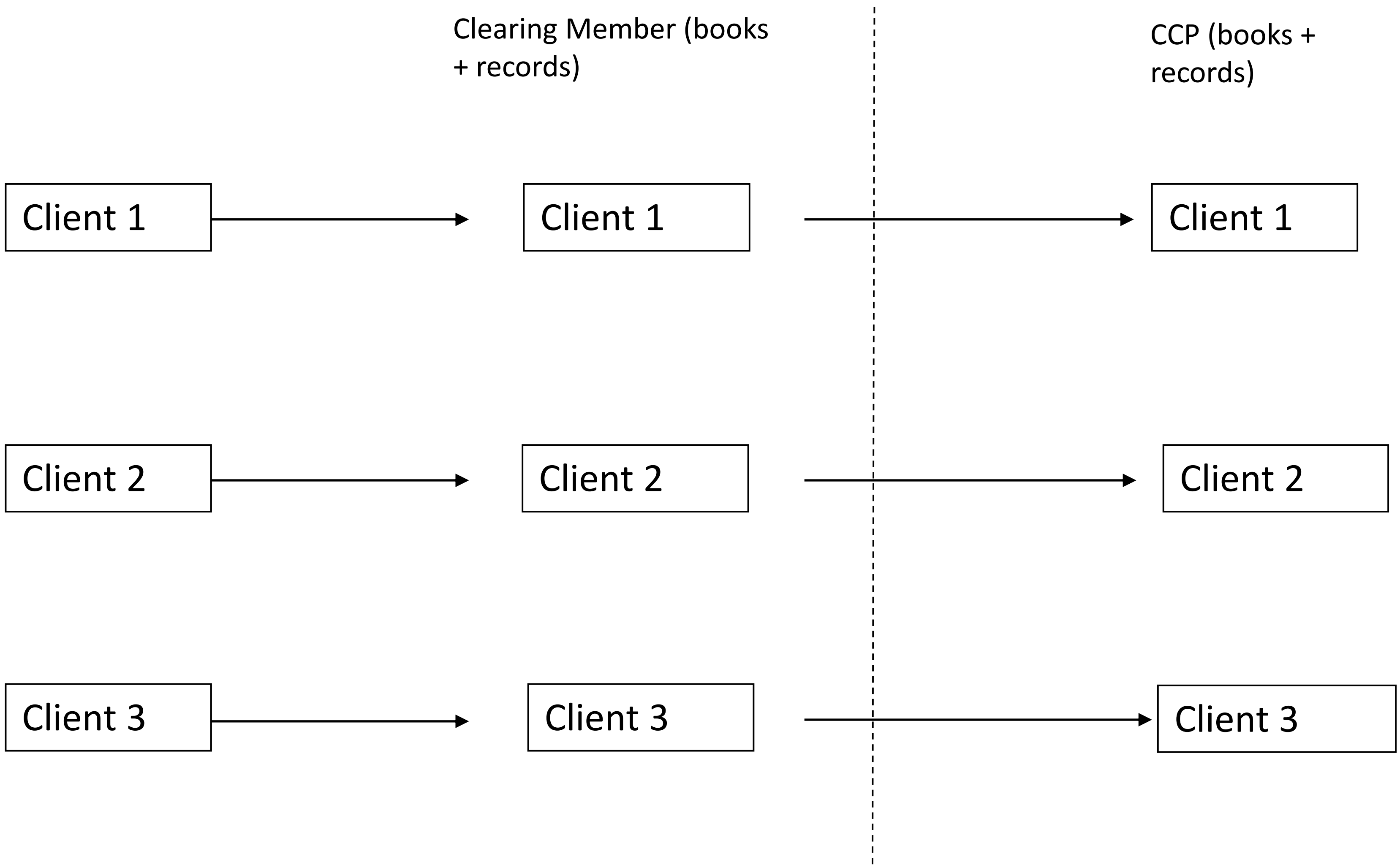
``Omnibus'' Segregation



Omnibus Segregation (2)

- Records and accounts kept at CCP which distinguish the assets and positions of the clients within the omnibus account from assets and positions within either the clearing member's house account or any other client account
- Positions can be netted within an omnibus account but not across accounts
- Assets covering positions in an omnibus account are not exposed to losses on positions recorded in any other account but within the account, one client's assets may be used to cover another client's positions – so fellow client risk will exist
- Excess collateral can be held at the clearing member level

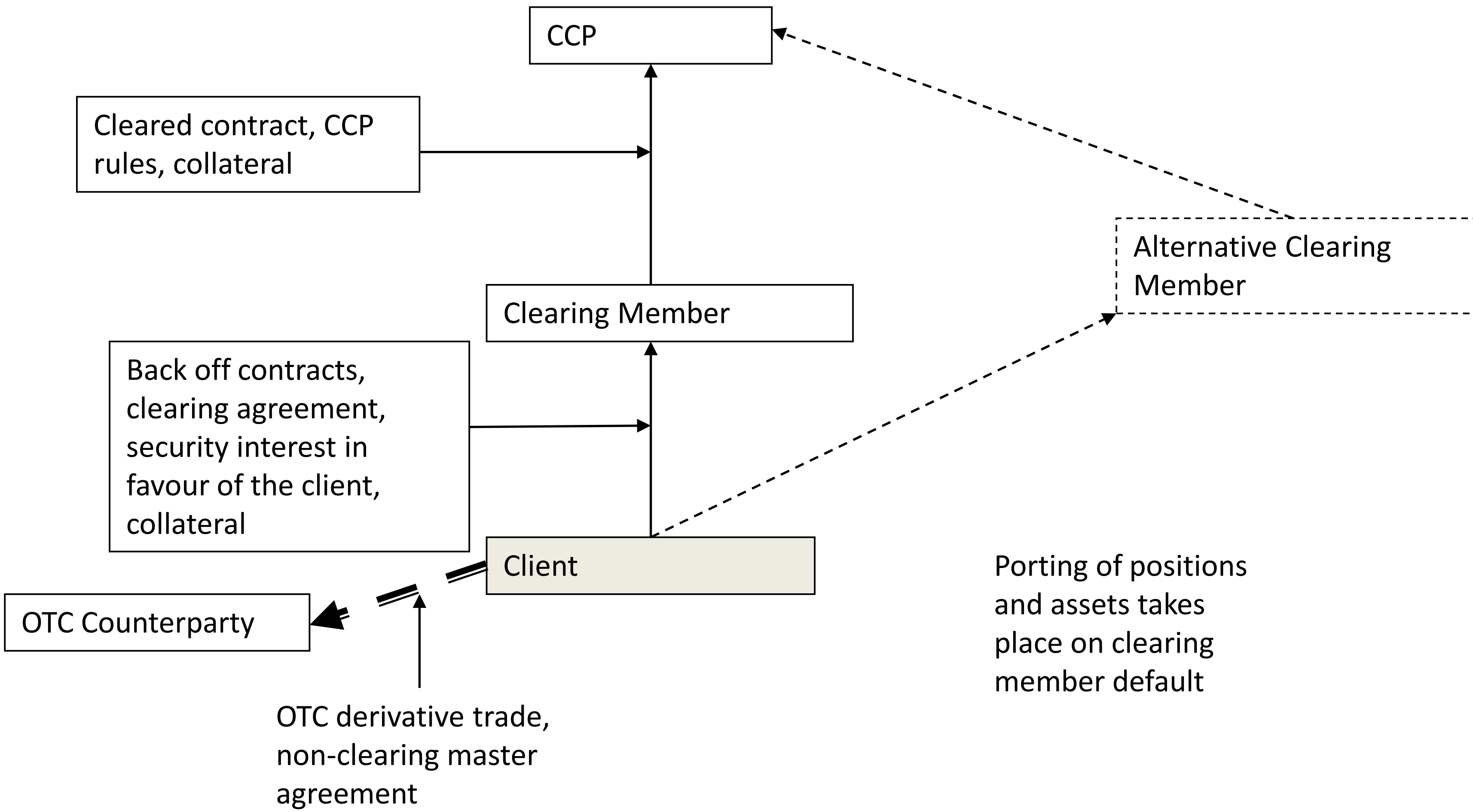
Individual Segregation



Individual Segregation

- Positions and assets distinguished from the positions and assets of any other client and the clearing member’s house account
- Positions within the account can be netted but positions cannot be netted across accounts
- Assets covering positions recorded in the account cannot be used to cover losses connected to positions recorded in any other account, so no fellow client risk
- Any collateral called by the clearing member which is in excess of that called by the CCP must be passed to the CCP and not held by the clearing member

Porting a Client Account (if CM defaults)



Should all OTC derivatives be centrally cleared?

- This is a complex question, which cannot be answered by a simple ``yes/no''.
- OTC markets are private markets (confidentiality a plus)
- Notional amounts are very large compared to typical contract sizes/lot sizes in listed markets
- Derivatives can be ``bespoke'', so the CCP would need to be equipped with complex risk-management systems.
- OTC derivatives can be hedges to other, even more bespoke transactions which are difficult to clear. Central clearing of one ``leg'' of a transaction but not another can introduce large costs to market participants.
- Are CCPs equipped to handle the massive credit exposure of the derivatives market?

These questions have been addressed in a Incremental way (asset class by asset class) the answers depend on the legal system of the country and on existing market practices pre-crisis.

Current issues of Interest to Practitioners (mostly legal)

- How resilient are CCPs in case of a large CP default? (We have never had a CP default in an OTC setting).
- Size of GF and how much each CP should contribute
- How are Client accounts segregated from House accounts?
- Porting clients of CPs
- Ways of closing out positions (active/passive/auction/hedging)
- Default management in general
- Replenishment of Guarantee fund
- Winding down CCP in orderly way
- Systemic risk posed by CCPs

Today's Major Clearing Houses

Inter bank payments: **ACH** (check clearing)

Securities: **DTCC, FICC, LCH.Clearnet, Eurex Clearing** (stocks, bonds)

Derivatives: **CME Group, LCH.Clearnet, Intercontinental Exchange (ICE), ICE Clear Europe** (swaps, credit default swaps)

Exchange-traded equity Options: The Options Clearing Corporation

BM&F Bovespa: manages 4 CCPs for different asset classes (like CME Group, which clears commodities, financials, and some OTC)

Hong Kong Exchanges and Clearing Ltd.: Securities and derivatives clearing
Both exchange-traded and OTC

DTCC

- DTC: clears securities: Equities and Corporate Bonds
- DTCC DerivSERV: Trade repository for OTC Credit Derivatives
- DTCC LoanSERV: Repository for Loans
- FICC: Fixed-income clearing corporation: Government Bonds and Mortgage Backed securities, General Collateral Fund repos, TBAs. Cross margining, settlement services

  Transactions processed in 2012: 1.1 Trillion USD
  Total Value of GCF repos in 2012: 193 Billion USD

- NYPC (New York Portfolio Clearing): Interest-rate derivatives clearinghouse which cross margins with FICC

Depositary Trust Company (DTC)

- Created in 1973
- Provides securities movements and settlement services for institutional
- Trades (between CPs which are banks and broker-dealers)
    - Settlement services
    - Corporate Actions processing
    - Issuers Services
    - Underwriting services
    - Global Tax services
- Member of the U.S. Federal Reserve system (it is a bank)

Value of Securities held at DTCC

Year	Value (trillion us)
2012	37.2
2011	33.7
2010	36.5
2009	33.9

CME Clearing

- Exchange Traded Derivative Products
  - Futures, Options
  - ED, E-mini, T bonds and notes, CL, Nat Gas
- OTC Financial Derivatives
- OTC Energy Derivatives

CME Clearing

CME Group’s Global Clearing and Service Capabilities

Choice based on customer demand

	Agency/FCM Model	Principal Model
	US Law / DFA Compliant Structure	**English Law / EMIR Compliant Structure**
Execution	ETD: CME MARKETS (CME, CBOT, NYMEX)	ETD: CME Europe
Clearing	OTC: Commodities, IRS, CDS, FX CME CLEARING US	OTC*: Commodities, IRS, FX CME CLEARING Europe
Clearing Member	CLEARING MEMBER (FCM)	CLEARING MEMBER (Broker/Bank)
Client	US or Non-US CLIENT	European or Non-US CLIENT

CME OTC Financial Derivatives

Product Type	Max 51 Year Maturity	Max 31 Year Maturity	Max 30 Year Maturity	Max 15 Year Maturity	Max 11 Year Maturity	Max 3 Year Maturity
Vanilla Fixed vs. Float	EUR, GBP, USD	AUD, CAD, CHF, DKK, JPY, NOK, SEK		HKD, NZD, SGD	CZK, HUF, MXN, PLN, ZAR	
Amortizing & Accreting Swaps (Variable Notional)	EUR, GBP, USD	AUD, CAD, CHF, DKK, JPY, NOK, SEK				
Basis Swap	EUR, GBP, USD	JPY	FED Funds			
Zero Coupon Swap	EUR, GBP, USD					
Overnight Index Swap (OIS)			EUR, GBP, JPY, USD			
Forward Rate Agreements (FRAs)						EUR, GBP, JPY, USD, ZAR

CME Exchange-Traded Products (FX, Energy)

FX

- Major Currencies (CLS-Eligible)
- Non-CLS Physically-Settled Currencies
- CLS-Settled Currencies
- Non-CLS Cash-Settled Currencies

Energy

- Biofuels
- Natural Gas
- Power
- Petroleum
- Emissions

Agriculture

- Fertilizer
- Cocoa

ICE Clearing US

AGRICULTURE >

With roots dating back more than 100 years, ICE Clear U.S. continues to serve the risk management needs of the softs market. Its cleared products include benchmark contracts such as **Sugar No.11**, **Cotton No. 2**, **Coffee "C"** and **Cocoa**.

EQUITY DERIVATIVES >

Equity derivatives cleared through ICE Clear U.S. include more than 20 futures based on **MSCI** geographic, sector and factor indices across emerging and developed markets, and **Russell equity index futures** and options.

FOREX (FX) >

ICE Clear U.S. offers capital efficiencies through the cross-margining of related products within a group of nearly 60 cross-currency futures. This group of futures contracts includes several emerging market currencies and the **U.S. Dollar Index**.

METALS >

We offer clearing for unique products in the precious metals market including mini-silver and mini-gold futures and options contracts designed through customer feedback.

CREDIT >

Expanding on our presence in the cleared CDS sector, we applied our innovation in credit risk management to the futures market. Working with Eris, ICE launched a cash-settled futures contract that replicates the economics of credit default swaps. It clears here at ICE Clear U.S. and is a valuable complement to our equity index contracts.

ICE Clear Europe

ENERGY >

ICE Clear Europe was established in 2008 to provide central counterparty clearing services to ICE's global energy markets. Since then, the clearing house has facilitated the introduction of clearing for more than 1,000 energy products.

INTEREST RATES >

For interest rates, we offer customers deep capital efficiencies across our product set. This includes the most liquid short-term European interest rate futures contracts, such as EURIBOR ® and Short Sterling, as well as contracts across the European sovereign and inter-bank yield curves. ICE Clear Europe also provides clearing for the dollar-denominated Eurodollar and GCF Repo futures.

EQUITY DERIVATIVES

Equity derivatives cleared through ICE Clear Europe include **MSCI**, **FTSE** and **Russell** index futures, as well as a comprehensive range of **single stock futures**, **single stock options** and the most extensive and widely traded portfolio of dividend adjusted stock futures. With index and single stock derivatives cleared through one central clearing house, customers can benefit from significant margin offsets and capital efficiencies.

CREDIT DEFAULT SWAPS >

Since 2009, ICE Clear Europe has provided a dynamic clearing framework for the credit default swap (CDS) market that includes same-day clearing, reliable end-of-day pricing and capital efficiencies generated through a sophisticated in-house risk model.

AGRICULTURE >

Many agriculture market participants from around the globe, including farmers and manufacturers, trade London's agriculture markets and clear their contracts through ICE Clear Europe. Products include futures and options contracts on **cocoa**, **Robusta coffee**, **white sugar** and **feed wheat**.

ICE Clear Credit

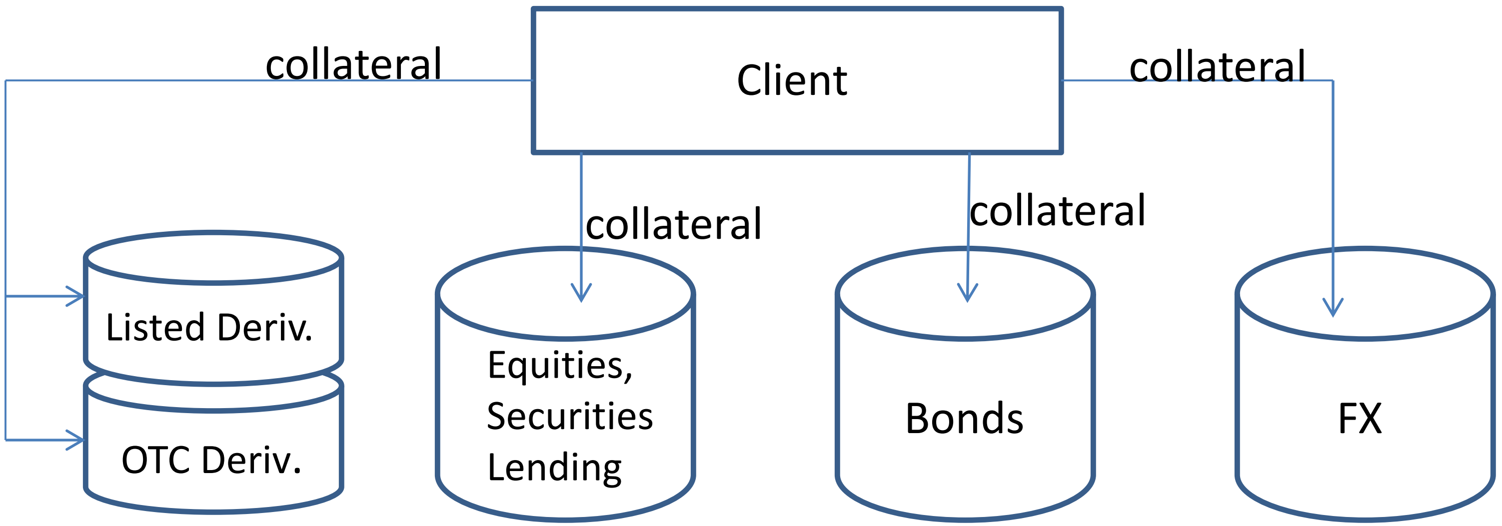
CREDIT DERIVATIVES >

ICE Clear Credit clears index and single-name CDS instruments across North American, European and emerging markets and offers portfolio margining opportunities to help increase capital efficiencies.

THE GLOBAL LEADER IN CLEARED CDS VOLUME

ICE CDS Clearing*	ICE Clear Credit**			ICE Clear Europe			
	Index	Corporate Single Names	Sovereign Single Names	Index	Corporate Single Names	Sovereign Single Names	Total***
Instruments	144	415	27	65	176	7	586
Number of Trades Cleared	1,044,921	685,889	101,253	477,394	631,273	17,658	2,961,381
Gross Notional Cleared	$47.7 trillion	$3.76 trillion	$1.01 trillion	€16.8 trillion	€2.97 trillion	$356 billion	$78.5 trillion
Buy-side Notional Cleared	$20.7 trillion	$98.5 billion	$25.3 billion	€43.1 billion	€4.37 billion	$3.40 billion	$20.9 trillion
Open Interest	$502 billion	$326 billion	$93.3 billion	€172 billion	€274 billion	$81.5 billion	$1.51 trillion
Clearing Members		30			22		52

The BM&F Bovespa clearing system



10,000 Derivatives Accounts
500,000 Equities Accounts
Full client segregation model – all accounts are subject to BM&F Bovespa margin not just broker-dealers

The CPSS/IOSCO Principles

(Bank of International Settlements, 2012, 2016)

Principles for Financial Market Infrastructures (CPSS – IOSCO 2012)

A Financial Market Infrastructure is defined as a system that facilitates the clearing, settling or recording of payments, securities, derivatives or other financial transactions.

Main categories:

1. Payment systems (PS)
2. Central securities depositories (CSD)
3. Securities Settlement Systems
4. **Central Counterparties (CCPs)**
5. Trade Repositories (TRs)

Principles 1-3: General Organization

Provide guidance on the general organization of an FMI to help establish a strong foundation for an FMI's risk management.

- **Strong legal basis**
- **Robust governance arrangements** that focus on the safety and efficiency of the FMI and that support the stability of the broader financial system
- Sets new standard for establishing an integrated and comprehensive view of its risks (e.g., risks to its participants)

Principles 4-7: Credit and Liquidity Risk-management

This is where quants have a say (`CCP validation')

- Systemically important payment system, SSS or CCP, required to fully collateralize its credit exposure to each participant with a high degree of confidence
- CCPS with more complex risk profiles (systemically important) would be required to withstand at least the default of 2 participants that would cause the largest damage
- Addresses the quality form and management of collateral
- Sets margin requirements for CCPs
    - Confidence level of >99% in terms of initial margin
    - Rigorous daily backtesting and monthly sensitivity analysis of risk margin model
- New guidance on Procyclicality and Wrong Way Risk
- Have sufficient liquidity under a wide range of stress scenarios

Credit and Liquidity Risk Management (continued)

- Requires explicit rules and procedures to address potentially uncovered liquidity shortfalls and replenishment of financial resources
- Stress tests for all of its financial resources should be conducted regularly
- Addresses the quality form and management of collateral
- On at least a monthly basis, relevant FMI are required to perform a comprehensive and thorough analysis stress testing scenarios, models and parameters and assumptions to verify that they are appropriate under current market conditions
- An FMI is also required to perform a full validation of its risk-management model at least annually, and an FMI should use the results of these stress tests to evaluate and adjust its resources as appropriate.

Principles 8 to 10: Settlement

- An FMI should be designed to provide clear and certain settlement. Settlement should be intra-day or real-time.
- Strengthens the former guidance on money settlements and strongly encourages the use of Central Bank by the FMI.
- Provides guidance for physical deliveries. Clear rules and obligations should be established regarding physical settlements of commodities.

Principles 11-12: Exchange-of-value settlement

- Requires that a CDS maintain securities in an immobilized form for transfer by book entry
- Requires elimination of principal risk by ensuring that one settlement takes place if and only if the linked obligation is made.

13-14: Default Management

- Appropriate procedures to handle participant defaults
- Maintain rules and procedures that enable the segregation and portability of the position of the participant’s customers and the collateral posted
- Appropriate segregation and portability with a CCP is especially important for central clearing of OTC derivatives

15-17: Business and Operational Risk-Management

- FMI s required to hold liquid net assets funded by equity equal to 6 months of current operating expenses to continue operations. The funds are in addition to funds for covering CP defaults and other risks

- Requires an FMI to safeguard its own assets and those of its participants and to maintain investment policies consistent with risk-management strategy.

- Operational reliability and resilience, business continuity plans, etc.

Principles 23-24: Transparency

- Rules, key procedures and market data require sufficient disclosure by an FMI to allow participants and prospective participants to have an understanding of risks, fees and material cost.

- Disclosure of market data by trade repositories is a new principle specific to TRs do disclose market data and allow participants, authorities and the public to make timely assessments of the OTC derivatives markets and, if relevant, other markets served by the TR.

Case Study I:
Sizing the Guarantee Fund of a CDS clearing house (2008)

Initial Margin

- Initial Margin (IM) is the collateral that the CCP requires from each account or CP to which it has exposure

- Variation Margin (VM) is just the amount of money that is credited or debited as securities change price. IM is a ``cushion'' that the CCP requires so that CPs are properly collateralized and

  (i) can meet variation margin
  (ii) their portfolios can be closed-out in case they are declared in default

- IM should take into account extreme but plausible market scenarios that could affect the value of member's portfolios (as well as their collateral) and create a uncollateralized loss in case of a default.

- Liquidity also plays an important role. Certain OTC derivatives trade in a private market (dealer-dealer or dealer-client). Can the market absorb the portfolio of a defaulted participant?

Guarantee Fund

- The Guarantee Fund is composed of contributions of Clearing Participants that should mutualize the uncollateralized losses in case of the default of market participants.

- Normally, the GF is part of a ``risk waterfall'' which defined in the Risk Policy of the CCP

- The sizing of the Guarantee Fund and how much each clearing member should contribute is key in the design of CCPs.

- The GF and other liquidity mechanisms depend on the nature of the business and, particularly, to the number of clearing participants

- Usually, clients of broker-dealers do NOT contribute to the GF, but add to the risk of the client account, which could represent more cost for the introducing broker.

Testing the size of the Guarantee Fund: The N-counterparty model

Suppose that the CCP has N counterparties, and there are n products.
The ``portfolio'' or aggregate positions of CPs can be described as a matrix

$$\mathbf{Q} = \begin{pmatrix} Q_{11} & Q_{12} & \dots & Q_{1N} \\ Q_{21} & Q_{22} & \dots & Q_{2N} \\ \dots & \dots & \dots & \dots \\ Q_{n1} & Q_{n2} & \dots & Q_{nN} \end{pmatrix}$$

where $Q_{ij} = \text{notional (dollar) exposure by CP \# } j \text{ on product \#} i$

$$\sum_{j=1}^{N} Q_{ij} = 0 \quad \text{for all } i = 1,\dots,n.$$

Market Risk

$\mathbf{X}' = \left(X_1, \ldots, X_n \right)$ = vector of shocks associated with a market move for the n products that are cleared (stress scenario)

We are interested in:

(a) specifying a reasonable joint probability distribution for the vector **X** and looking at extreme values for the N portfolios,

(b) choosing a historical period in the past that is very volatile (e.g. Oct 1987 for stocks, Sep 2008 for credit) and letting **X** represent the historical market move(s) over those periods.

MTM vector for the model with N clearing participants

Given a portfolio matrix **Q** and a market shock **X**, the change in the value of the position of the jth CP is

$$Y_j = \sum_{i=1}^{n} X_i Q_{ij}, \quad j = 1, \ldots, N$$

$$\mathbf{Y}' = \mathbf{X}' \mathbf{Q}$$

Margin is modeled as a function of the position. For simplicity, we can Assume that it is a linear function of the position (e.g. prop to exposure)

$$m\left(Q_{*j}\right) = \sum_{i=1}^{n} m_i Q_{ij}$$

FINANC CONCEPTS

Mathematical model for simulating CCP exposure –linear margin

$$Q_{ij} = R_{ij} - \frac{1}{n}\sum_{i=1}^{n} R_{ij} \qquad \mathbf{R} = \text{ random matrix with IID entries}$$

$$\mathbf{Q} = \left(\mathbf{I} - \frac{1}{n}\mathbf{1}\otimes\mathbf{1} \right)\cdot\mathbf{R} = \mathbf{AR}$$

$$Z_j = Y_j - \sum_{i=1}^{n} m_i Q_{ij} = \sum_{i=1}^{n} X_i Q_{ij} - \sum_{i=1}^{n} m_i Q_{ij}$$

$$= \sum_{i=1}^{n} \left(X_i - m_i \right) Q_{ij}$$

$$\mathbf{Z} = \left(\mathbf{X} - \mathbf{m} \right)' \mathbf{AR}$$

Margin as a multiple of portfolio variance (correlation offset)

``VaR'' margin:

$$m\left(Q_{*j}\right) = m\sqrt{\sum_{ik=1}^{n} \sigma_i \sigma_k \rho_{ik} Q_{ij} Q_{kj}}$$

$$= m\sqrt{\mathbf{e'_j\, Q'CQe_j}}$$

$$Z_j = \sum_{i=1}^{n} X_i Q_{ij} - m\sqrt{\sum_{ik=1}^{n} \sigma_i \sigma_k \rho_{ik} Q_{ij} Q_{kj}}, \qquad \mathbf{Q} = \mathbf{AR}$$

FINANC-CONCEPTS

Monte Carlo simulations: testing the margin/GF requirements of a Clearinghouse for CDS index products

- Reference period: the week of 9/11/2008 to 9/18/2008 (defaults of Lehman Brothers)

- Data: bid-ask prices, estimates of liquidity

Steps taken:

- **Code** the margin requirements proposed by the architects of the clearinghouse

- **Simulate 100K market configurations (portfolios)** and analyze what happens in in the event that we have to liquidate two insolvent CPs . Does the clearinghouse remain solvent?

- What are the **worst-case scenarios** for the CCP in terms of market configurations?

Stress-testing Margin and GF requirements for a clearinghouse for index CDS through the Lehman Brothers default week.

CDX Index Reference Prices

Date	Instrument	HY.9.5Y	HY.10.5Y	IG.9.5Y	IG.9.10Y	IG.10.5Y	IG.10.10Y	HV.9.5Y	HV.10.5Y
	Last Price	90.28	93.6	96.38	95.38	100.38	100.83	90.38	98.88
9-Sep	Last Spread	679	686	155	144	146	139	416	379
		Volume-weighted average quotes							
	Bid Price	87	90.1	94.5	92.5	98	98.1	87.9	95.8
	Ask Price	87	90.1	94.5	92.5	98	98.1	87.9	95.8
	Bid Spread	798	801	207	187	198	181	496	462
16-Sep	Ask Spread	798	801	207	187	198	181	496	462
		Worst case quotes							
	Bid Price	87.94	91.1	94.9	93.36	98.55	98.97	88.57	96.43
	Ask Price	86.21	89.17	93.66	90.67	97.06	96.07	86.49	94.13
	Bid Spread	763	766	196	174	185	169	475	445
16-Sep	Ask Spread	828	831	231	216	222	210	545	510

n=8

FINANC ONCEPTS

CDX Positions per firm
(in millions of USD)

Firm	Short Protection	Long Protection	Net	Total Notional
CP1	16,917	1,275	(15,642)	18,192
CP2	14,497	1,605	(12,892)	16,102
CP3	13,267	1,861	(11,406)	15,128
CP4	923	17,228	16,305	18,151
CP5	705	6,472	5,767	7,177
CP6	2,527	8,194	5,667	10,721
CP7	12,148	13,755	1,607	25,903
CP8	4,911	2,065	(2,846)	6,976
CP9	3,596	7,455	3,859	11,051
CP10	6,999	16,580	9,581	23,579
CLEARINGHOUSE	76,490	76,490	-	-

N=10 participants

Margin Requirements (in million USD)

Firm	Guarantee Fund	GF+Min Req	Risk Margin	Concentration	Total Required
CP1	458.9	458.9	468.8	103.2	1,030.9
CP2	207.9	207.9	265.1	30.7	503.7
CP3	110.0	110.0	233.9	26.2	370.1
CP4	6.5	20.0	186.0	4.7	210.7
CP5	3.7	20.0	105.3	0.0	125.3
CP6	3.6	20.0	102.0	0.0	122.0
CP7	9.6	20.0	272.2	24.7	316.9
CP8	2.0	20.0	57.9	2.7	80.6
CP9	4.0	20.0	113.1	0.0	133.1
CP10	12.4	20.0	353.3	51.1	424.4
CLEARINGHOUSE	818.6	916.7	2,157.6	243.3	3,074.4

Estimated Profit/Loss: Liquidation on Sep 16, 2008

Volume-weighted average quote

Firm	HY.9.5Y	HY.10.5Y	IG.9.5Y	IG.9.10Y	IG.10.5Y	IG.10.10Y	HV.9.5Y	HV.10.5Y	Total
CP7	68.4	100.2	(158.7)	(81.4)	177.8	(24.0)	28.4	5.9	116.6
CP2	52.6	(71.0)	(14.4)	(61.4)	(121.8)	(68.4)	(14.0)	(42.5)	(340.9)
CP1	27.8	(277.7)	(10.1)	(80.4)	(71.2)	(44.2)	(25.9)	13.2	(468.5)

Worst-case quote on Sep 16

Firm	HY.9.5Y	HY.10.5Y	IG.9.5Y	IG.9.10Y	IG.10.5Y	IG.10.10Y	HV.9.5Y	HV.10.5Y	Total
CP7	48.8	71.6	(229.7)	(133.1)	136.7	(41.8)	20.7	4.7	(122.1)
CP2	37.6	(89.8)	(20.9)	(100.5)	(169.9)	(119.3)	(22.0)	(65.6)	(550.4)
CP1	19.8	(351.5)	(14.6)	(131.6)	(99.3)	(77.1)	(40.7)	10.5	(684.3)

FINANCECONCEPTS

Comparing Shortfalls with Clearinghouse requirements

Worst-case quote on Sep 16

Firm	**Worst Case**	**Total Req.**	Risk Marg.	Concentration	Guarantee Fund
CP7	**(122.1)**	**316.9**	272.2	24.7	20.0
CP2	**(550.4)**	**503.7**	265.1	30.7	207.9
CP1	**(684.3)**	**1,030.9**	468.8	103.2	458.9

FINANC CONCEPTS

Comparing Shortfalls with Clearinghouse requirements

Volume-weighted average quote

Firm	VWAQ	Total Req.	Risk Marg.	Concentration	Guarantee Fund
CP7	116.6	316.9	272.2	24.7	20.0
CP2	(340.9)	503.7	265.1	30.7	207.9
CP1	(468.5)	1,030.9	468.8	103.2	458.9

FINANC CONCEPTS

Firm positions on September 16 (notional in USD millions)

Firm	HY.9.5Y	HY.10.5Y	IG.9.5Y	IG.9.10Y	IG.10.5Y	IG.10.10Y	HV.9.5Y	HV.10.5Y
CP7	2,084	2,864	(8,444)	(2,825)	7,472	(879)	1,145	190
CP2	1,605	(2,028)	(767)	(2,133)	(5,116)	(2,506)	(566)	(1,381)
CP1	847	(7,934)	(535)	(2,793)	(2,991)	(1,619)	(1,045)	428

Simulating different portfolios

$n = 8 \quad CDX.HY, CDX.HV, CDX.IG, \; \text{5 years,10 years}$

$N = 10, \; \text{primary dealers in NA index CDS}$

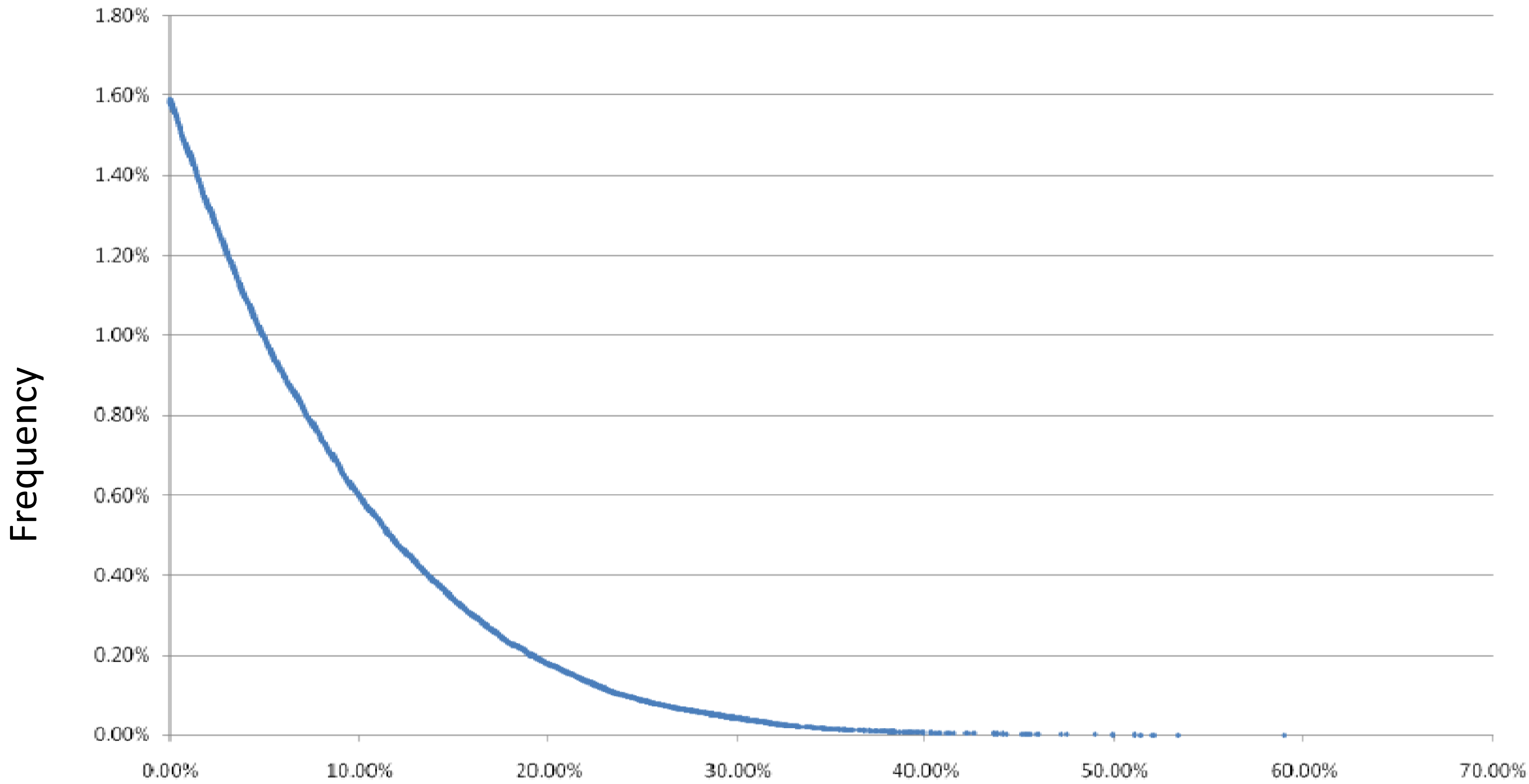
$\mathbf{R} = \text{Uniformly distributed entries (long or short protection), bounded by 7 billion USD}$

$\mathbf{X} = \text{Shocks to prices over the week of Sep 11/ Sep 18, 2008}$

Margin and GF rules proposed by clearing houses

Objective: explore the ``phase space'' of all possible portfolios that could exist in this period and find hw and why extreme losses could happen.

Simulated losses for CCP in case of liquidation of 2 insolvent CPs (% of Total Guarantee Fund)



Shortfall as % of total GF,
after applying GF of each CP

FINANC CONCEPTS

WORST SCENARIO	CP1	CP2	CP3	CP4	CP5
Instrum. 1	-3650.5	2718.5	2237.5	-3288.5	1744.5
Instrum. 2	-1146.4	-1547.4	2970.6	-1129.4	419.6
Instrum. 3	-491.6	3142.4	-547.6	481.4	2472.4
Instrum. 4	2263	-718	-2858	-1325	-724
Instrum. 5	-378	-450	-174	11	392
Instrum. 6	-57.1	170.9	104.9	710.9	434.9
Instrum. 7	144.1	284.1	144.1	-347.9	-367.9
Instrum. 8	179.5	-116.5	186.5	169.5	-299.5
NET EXPOSURE	-3137	3484	2064	-4718	4072
LOSS BEFORE MARGIN	$138,426,530	$44,894,614	$58,381,840	$188,252,980	$79,538,277
MARGIN	-$65,873,155	-$44,894,614	-$29,164,467	-$129,564,724	-$79,538,277
LOSS AFTER MARGIN	72,553,375	0	29,217,373	58,688,256	0

WORST SCENARIO	CP6	CP7	CP8	CP9	CP10
Instrum. 1	1702.5	-2989.5	792.5	2007.5	-1274.5
Instrum. 2	2394.6	-3985.4	765.6	2549.6	-1291.4
Instrum. 3	-4537.6	-2400.6	3074.4	2952.4	-4145.6
Instrum. 4	-3292	3438	-104	901	2419
Instrum. 5	138	25	-93	-668	1197
Instrum. 6	-803.1	-645.1	-483.1	777.9	-211.1
Instrum. 7	192.1	254.1	-556.9	116.1	138.1
Instrum. 8	-384.5	149.5	-496.5	550.5	61.5
NET EXPOSURE	-4590	-6154	2899	9187	-3107
LOSS BEFORE MARGIN	$280,914,470	$304,510,830	$103,513,964	$108,830,733	$165,467,430
MARGIN	-$122,203,546	-$145,204,075	-$103,513,964	-$108,830,733	-$99,840,218
LOSS AFTER MARGIN	158,710,924	159,306,755	0	0	65,627,212
TWO LIQUIDATIONS	318,017,679				
GUARANTEE FUND	-$200,000,000				
SHORTFALL	59.01%				

Effects of netting the positions of 2 insolvent CPs

	CP6	CP7	NET	P/L AFTER NETTING
Instrument 1	1702.5	-2989.5	-1287	-$35,006,400
Instrument 2	2394.6	-3985.4	-1590.8	-$74,889,000
Instrument 3	-4537.6	-2400.6	-6938.2	-$230,341,600
Instrument 4	-3292	3438	146	$2,715,600
Instrument 5	138	25	163	$50,614,200
Instrument 6	-803.1	-645.1	-1448.2	-$64,146,400
Instrument 7	192.1	254.1	446.2	$8,072,600
Instrument 8	-384.5	149.5	-235	-$11,162,500
NET EXPOSURE (mm$)	-4590	-6154	-10744	
P/L AFTER NETTING				**-$354,143,500**
RISK MARGIN + CC	-122,203,546	-145,204,075		**-267,407,621**
LOSS AFTER MARG.				**$86,735,879**
GUARANTEE FUND				**-$200,000,000**
EXCEEDENCE				**0%**

If two or more participants must be liquidated, offsetting positions can be cancelled out. This is known as netting.

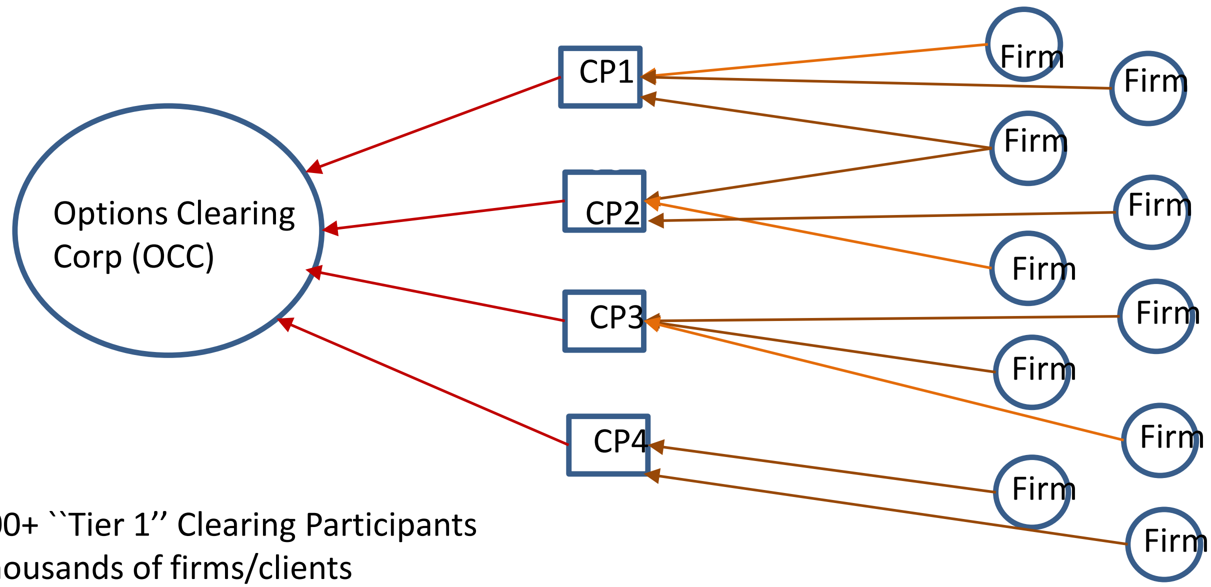
FINANC CONCEPTS

Case Study II:
Monte Carlo RM system for Exchange Traded Equity Options CCP:
The Options Clearing Corporation (2013)

U.S. Equity Derivatives in Numbers

- Number of underlying securities with options (Stocks, Indices, ETFs) : ~ 9,000
- Number of Open contracts per underlying asset: ~ 100 (average)
- Total number of open contracts on a given day: ~ 1,000,000
- Professional trading firms position size ~ 25,000+ positions
- Size of Daily Mark-to-Market: 60 MB compressed zip file
- 5 Years historical MTM : 75 GB
- Commercial data vendors: Hanweck Option Volatility Service, IVY OptionMetrics
- Intraday data: orders of magnitude larger!

The Market Infrastructure: Clearing & Initial Margin



Firm: non-clearing organization or retail client, HF

- 200+ ``Tier 1'' Clearing Participants
- Thousands of firms/clients
- Arrows represent posting collateral (initial margin)

CP Risk Management : STANS ``System for Theoretical Analysis and Numerical Simulations'' (2006)
Non-CP Risk Management: CPM ``Customer Portfolio Margin'' (SEC-approved IM for non-clearing firms)

Customer Portfolio Margin

(FINRA rule 4210)

- Apply stress tests or `slides' by using mathematical formulas to create new market values for positions based on theoretical movements of the underlying stock
- Move the price of the underlier by between **+6% and -8% at 10 equal intervals (grid)** for broad indexes
- Move by +15% and -15% for ETF, equities
- Add worst losses for each separate underlying stock & options to obtain CPM requirement
- CPs must use an **SEC/FINRA approved model** to margin their clients (minimum requirement)
- Currently, the Option Clearing Corporation's **TIMS** is the only approved model for CPM

CPM/TIMS is very rigid, does not recognize any correlations except for Broad-Based Indexes. (Basically, it's a 1980's approach).

Reference: http://www.optionsclearing.com/risk-management/cpm/

STANS: Initial Margin For CPs (2006)

- Grids are replaced by a Monte Carlo Simulation for 2-day changes in all (correlated) underlying prices
- Amplitudes of moves based on estimated Standard Deviations, **correlations** between underlying stocks taken into account via MC
- Portfolios re-priced 10,000 times using **10,000 theoretical changes** of the underlying stocks based on MC.

$$Base\ Charge = ES_{99\%}$$

(Expected shortfall @ 99%)

$$Dependence\ Charge = 0.25 \times \left[\max\left(ES^{H}_{99.5\%}, ES^{\rho=1}_{99.5\%}, ES^{\rho=0}_{99.5\%}\right) - ES_{99\%}\right]$$

(Correlations scenarios)

$$Concentration\ Charge = 0.25\ \times \left[\ {}^{2}cES_{99.5\%} +^{2} rES_{99.5\%} - ES_{99\%}\right]$$

(Worst 2-asset portfolio)

$$STANS\ IM = Base\ Charge + Dependence\ Charge + Concentration\ Charge$$

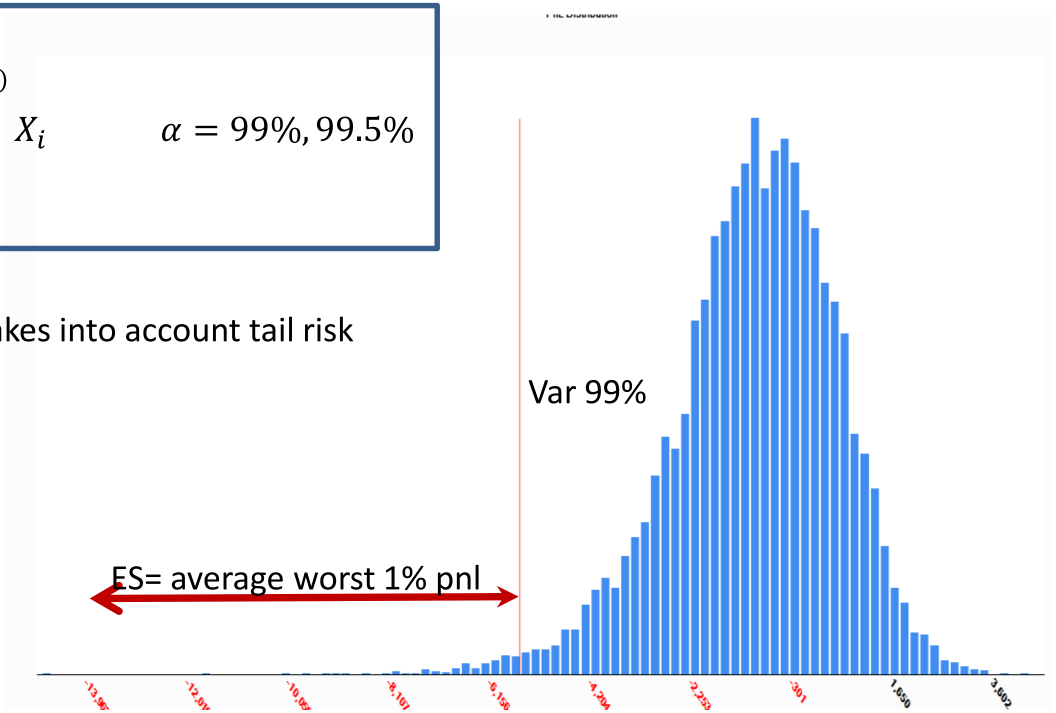
http://www.optionsclearing.com/risk-management/margins/

Expected Shortfall (ES)

- Given $N = 10{,}000$ scenarios for theoretical portfolio changes: $X_1 < X_2 < X_3 < \cdots < X_N$

$$ES_\alpha = \frac{1}{N(1-\alpha)} \sum_{i=1}^{N(1-\alpha)} X_i \qquad \alpha = 99\%, 99.5\%$$

- ES is better than Value at Risk because it takes into account tail risk beyond VaR



Improving STANS (2013-2016)

- STANS ``scenarios'' only take into account changes in the **underlying asset**
- STANS does not shock the **implied volatility (IVOL) of the options**

`frozen IVOL'

STANS (2006):	$BS(S, T, K, \sigma) \rightarrow BS(S + \Delta S, T, K, \sigma)$
NEW STANS (2016):	$BS(S, T, K, \sigma) \rightarrow BS(S + \Delta S, T, K, \sigma + \Delta\sigma)$

- Motivation: For longer-dated options, IVOL risk can be more important than underlying stock risk
- Futures and ETFs referencing the VIX volatility index blur the boundary between what is an underlying asset and what is an implied volatility.
- M. A. and Finance Concepts LLC advised the OCC in creating the improved STANS (2016)
- Improved STANS was recently approved by SEC

New STANS (SEC Filing)

File No. SR-OCC-2015-804
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SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549

Form 19b-4

Advance Notice
by

THE OPTIONS CLEARING CORPORATION

Pursuant to Rule 19b-4 under the
Securities Exchange Act of 1934

File No. SR-OCC-2015-804
Page 4 of 41

Item 1. **Text of the Advance Notice**

In accordance with Section 806(e)(1) of the Payment, Clearing, and Settlement Supervision Act of 2010 ("Payment, Clearing and Settlement Supervision Act")[1] and Rule 19b-4(n)(1)(i)[2] of the Securities Exchange Act of 1934 ("Act"),[3] this advance notice is filed by The Options Clearing Corporation ("OCC") in that would modify OCC's margin methodology by incorporating variations in implied volatility for "shorter tenor" options within the System for Theoretical Analysis and Numerical Simulations ("STANS").

Item 2. **Procedures of the Self-Regulatory Organization**

The proposed change was approved for filing with the Commission by the Board of Directors of OCC at a meeting held on May 20, 2015.

Questions should be addressed to Stephen Szarmack, Vice President and Associate General Counsel, at (312) 322-4802.

Item 3. **Self-Regulatory Organization's Statement of the Purpose of, and Statutory Basis for, the Advance Notice**

Not applicable.

Item 4. **Self-Regulatory Organization's Statement on Burden on Competition**

Not applicable.

Item 5. **Self-Regulatory Organization's Statement on Comments on the Advance Notice Received from Members, Participants or Others**

Written comments were not and are not intended to be solicited with respect to the

http://www.optionsclearing.com/components/docs/legal/rules_and_bylaws/sr_occ_15_804.pdf

Principles and construction of IVOL scenarios

1. Statistical Model

- Identify the model risk factors (stocks, subset of IVOLS) – data modeling
- Estimate the Volatility of the Risk Factors
- Estimate Correlations between Risk Factors (intra- and inter-commodity risk offsets)

2. Numerical Implementation

- Perform Monte-Carlo Simulation of changes in RFs for 2-day horizon
- Using the N=10K random scenarios, re-value all the listed options with non-zero open interest N times

3. Technological challenge

- Generate daily updated file with 10,000 theoretical price changes for each instrument

Statistical Model

- How can we parametrize the options market for a given underlying asset?

  Answer : **Build an ``implied volatility surface'' for each asset**

- How can we parametrize the implied volatility surface with the ``right'' number of degrees of freedom

  Answer: **Use principal components analysis on the correlation matrix of IVOLs for each asset to find a minimal set of risk factors**

Academic study (M.A., Doris Dobi, & Finance Concepts)

- Data source: IVY OptionMetrics (available at WRDS for colleges), which gives EOD prices from OPRA

- Study: consider 4,000 optionable securities with 52 delta-maturity points per underlying asset + underlying asset (53 points per asset)

- Use smoothing of implied volatilities of options to generate a constant-maturity, constant-moneyness dataset for each day:

$$\delta = (20,25,30,\ldots,75,80,100), \quad \tau=(30,91,182,365)$$

BS Delta (13 strikes) 4 settlement dates

- Historical period: August 31, 2004 to August 31, 2013

http://www.math.nyu.edu/faculty/avellane/DorisDobiThesis.pdf

Correlation Analysis for Stock and IVOL surface

- For each underlying stock, ETF or index, we formed the matrix

$$X = \begin{bmatrix} X_{1,1} & \cdots & X_{1,53} \\ \vdots & \ddots & \vdots \\ X_{T,1} & \cdots & X_{T,53} \end{bmatrix}$$

T=1257 (5 years history)

$X_{t,i}$ = standardized returns of stock (i=1) or of the IVOL surface point labeled i

- Perform an SVD of the volatility surface for each of the underlying assets in the dataset.
- Analyze eigenvectors and eigenvalues to find out how correlated IVOLS are for a given underlying asset

Principal Component Analysis of the IVOL Correlation matrix: separating signal from noise

- Question: how many **significant** eigenvalues/eigenvectors do the correlation matrices of implied volatilities have?

- **Random matrix theory:** if X is a matrix of uncorrelated IID random variables with mean zero and variance 1, of dimensions $T \times N$, the histogram of the eigenvalues of the correlation matrix

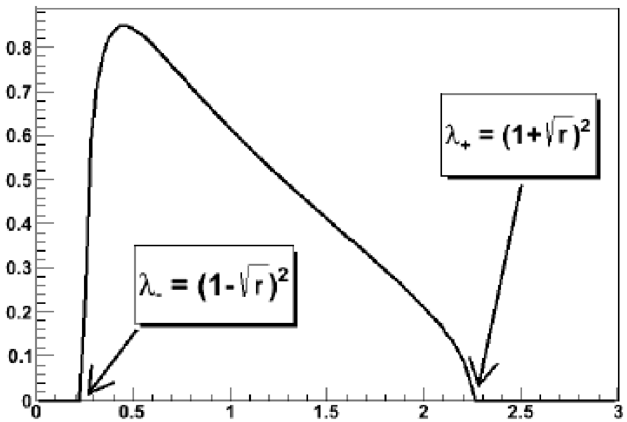
$$C = \frac{1}{T} X X'$$

approaches, as N and T tend to infinity with ratio N/T=γ, the Marcenko-Pastur distribution:

$$\frac{\#\{\lambda : \lambda \leq x\}}{N} \quad \rightarrow \quad MP(\gamma; x) = \int_0^x f(\gamma; y) dy$$

$$\mathrm{N} \rightarrow \infty, \frac{N}{T} \rightarrow \gamma$$

Marcenko-Pastur distribution & threshold



$$f(\gamma; x) = \left(1 - \frac{1}{\gamma}\right)^+ \delta(x) + \frac{1}{2\pi\gamma} \frac{\sqrt{(x-\lambda_-)(\lambda_+ - x)}}{x} \qquad \lambda_- \leq x \leq \lambda_+$$

$$\lambda_- = (1-\sqrt{\gamma})^2 \quad \lambda_+ = (1+\sqrt{\gamma})^+$$

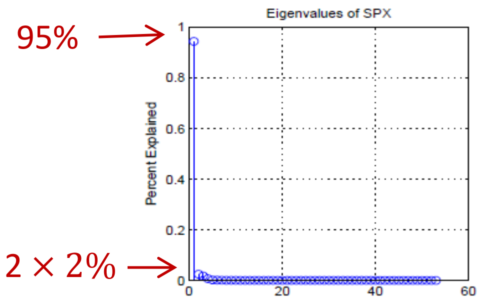
← Marcenko-Pastur threshold

The theoretical top EV for N=53 and T=1250 is $\lambda_+ = \left(1 + \sqrt{\frac{53}{1257}}\right)^2 = 1.45$

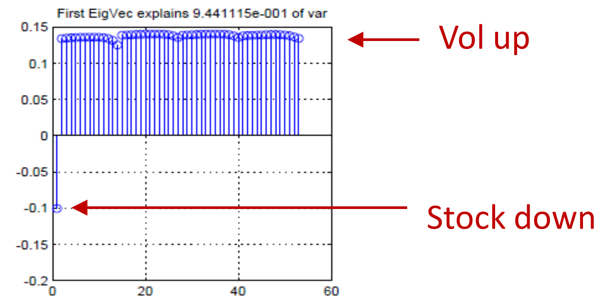
Assumption: Eigenvalues of the correlation matrix associated with non-random features should lie **above the MP threshold** (within error; Laloux, et al (2000),Bouchaud and Potters (2000))

Analysis of SPX volatility surface

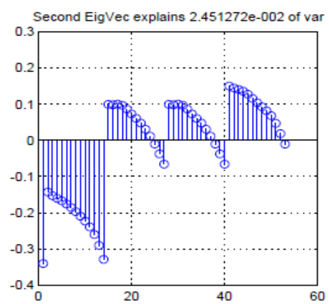
Spectrum

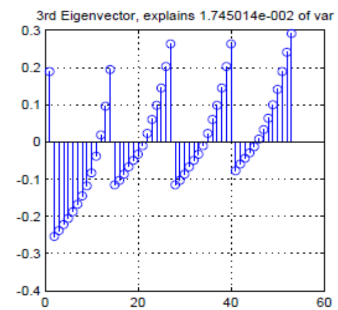


First eigenvector



Lambda_1	50.04
Lambda_2	1.3
Lambda_3	0.93





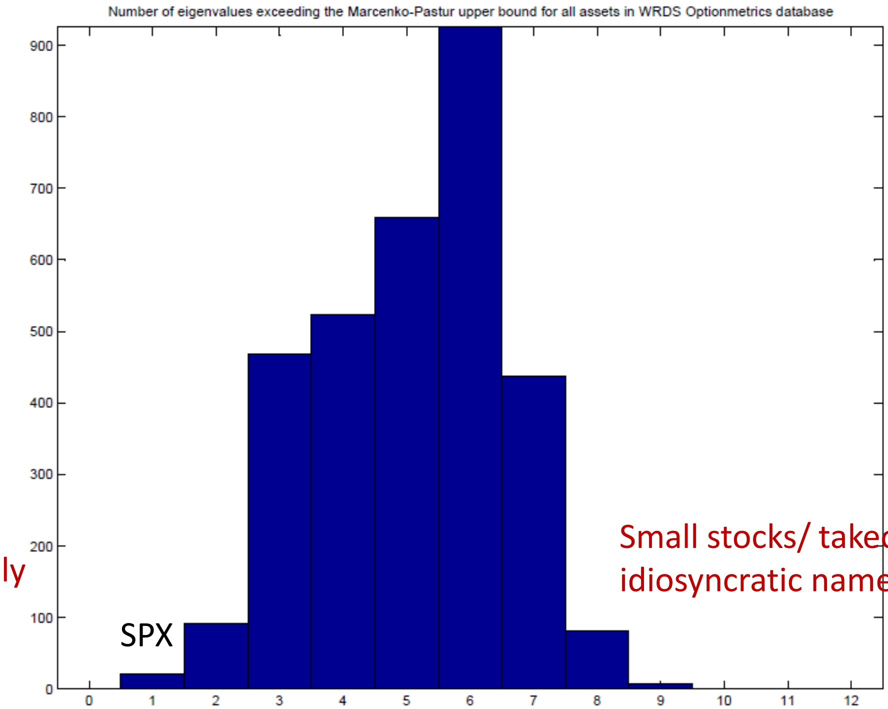
MP threshold= 1.45

1 significant eigenvalue (out of 53 possible)

Second eigenvector

Third eigenvector

Number of EVs above the MP threshold for all optionable assets



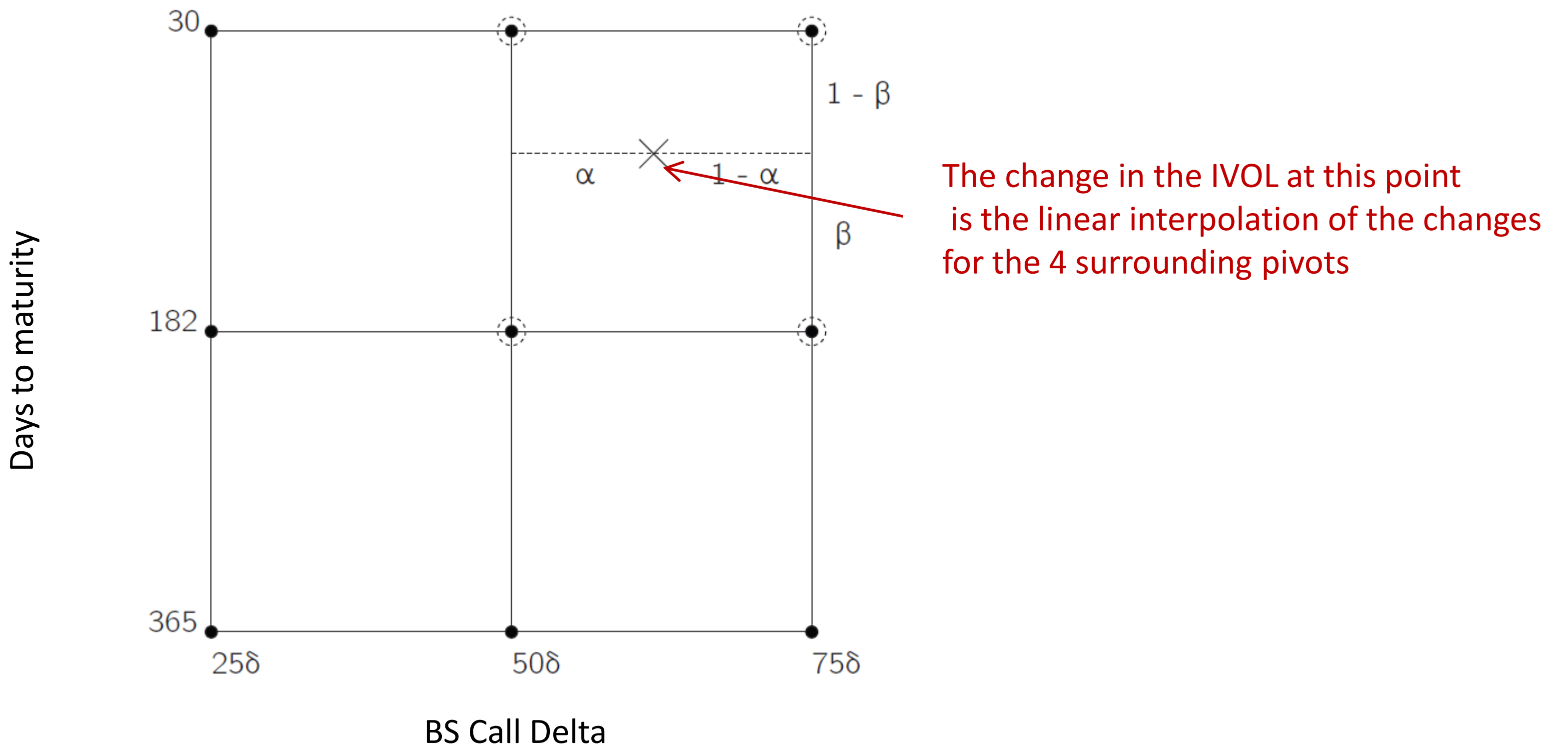
Well-known/ broadly traded names

Small stocks/ takeovers/ idiosyncratic names

Dimension reduction

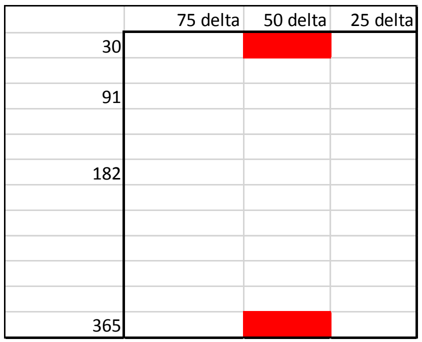
- Knowing that DF<=9, from PCA, choose a small set of points on the IVS and their fluctuations to model the changes in implied volatilities for each underlying.
- A ***pivot*** is a point on the delta/tenor surface used as a risk factor
- *A **pivot scheme**:* is a grid of pivots, which will be used to interpolate the implied volatility returns.
- Goal: find a pivot scheme that approximates well movements of the full volatility surface

Example: 9-pivot scheme interpolates IVOL shocks from a discrete set of 9 moves

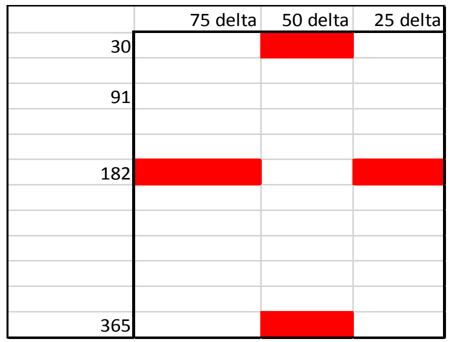


Some of the pivot schemes that were tested

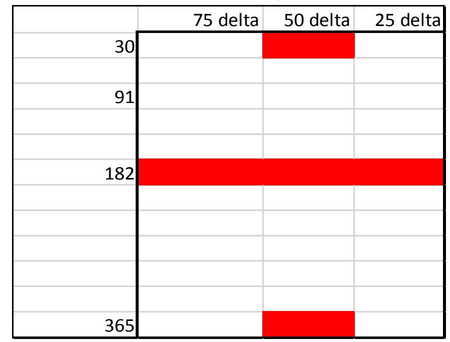
2 pivots



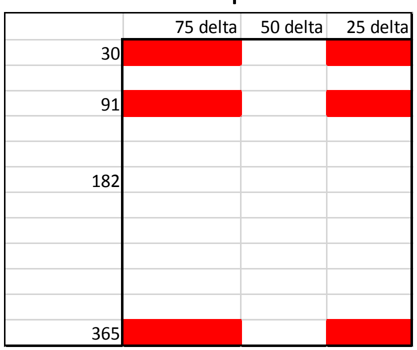
4 pivots



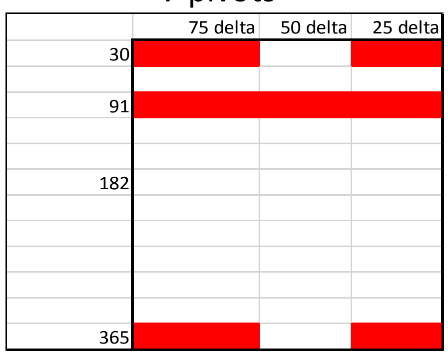
5 pivots



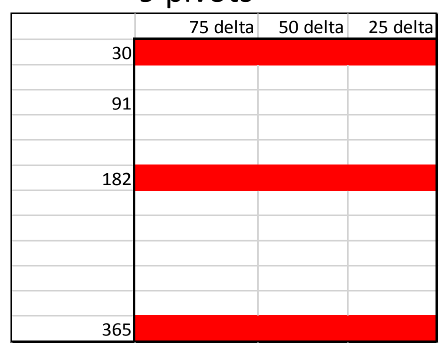
6 pivots



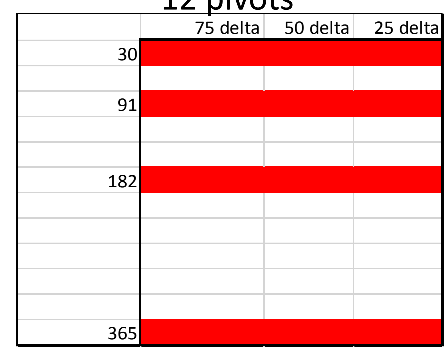
7 pivots



9 pivots



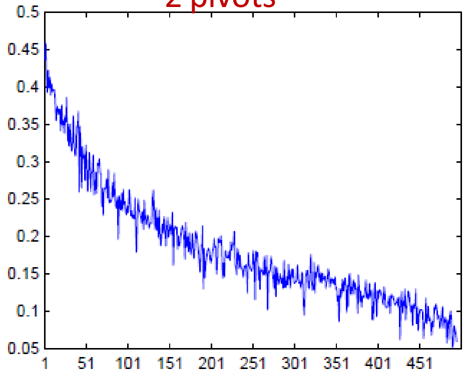
12 pivots



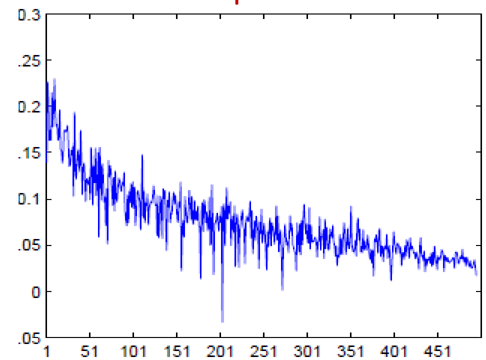
Increasing the number of pivots results in a better approximation of EV1

2 pivots

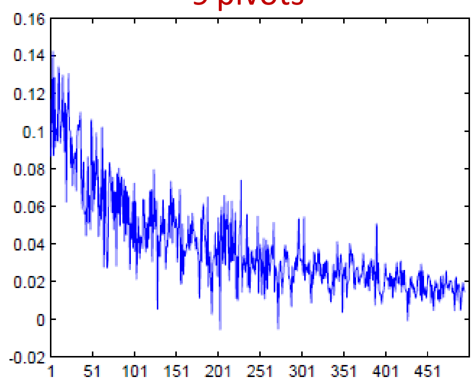
% Error



6 pivots



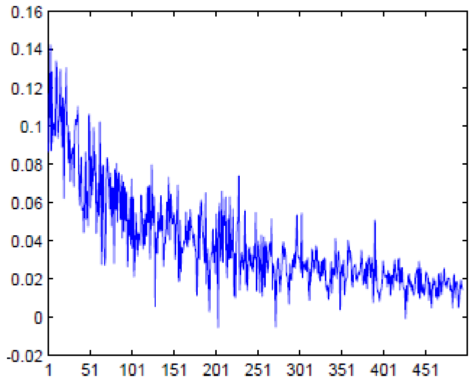
9 pivots



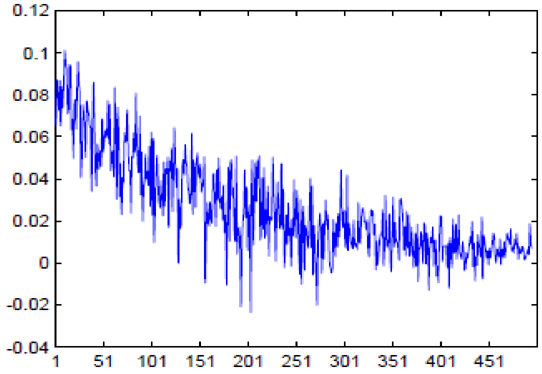
Cross section of S&P 500 constituents.

12- pivot scheme does slightly better, but not much better, than 9 pivots

9 pivots



12 pivots



- 9 pivots seems like an appropriate number to parameterize all the IVS in the data.
- This was confirmed by dynamic PCA with smaller window (Dobi's thesis, 2014)
- Also confirmed by backtesting initial margin on many test portfolios (tail risk)

Modeling the Volatility of the Risk Factors (EWMA)

$$X_{n+1} = \sigma_n \epsilon_{n+1}$$

$${\sigma_{n+1}}^2 = {\sigma_n}^2 + \alpha {X_{n+1}}^2 - \beta {\sigma_n}^2$$

GARCH 1-1 model
(Engle & Granger)

This model has ``persistence'' built in, in the sense that the change In volatility is affected by the contemporaneous squared-return, but with memory loss.

$${\sigma_n}^2 = \frac{\beta}{1-(1-\beta)^{T+1}} \sum_{j=0}^{T} (1-\beta)^j {X_{n-j}}^2$$

Exponentially weighted moving average of past square returns

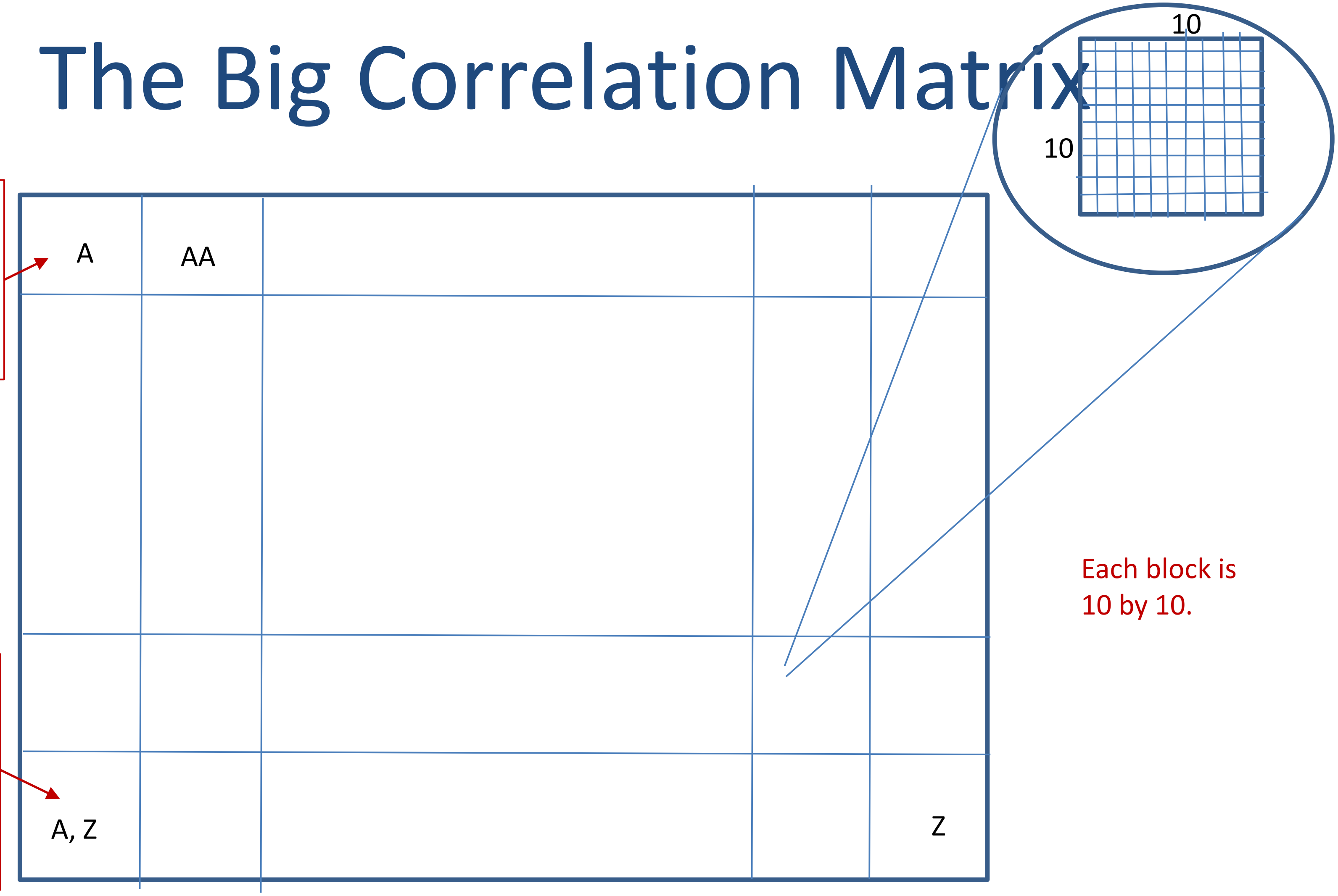
Putting the model together (inter-commodity correlations)

- We determined that for each equity and its listed options, the **9-pivot model** is sufficient to describe statistically the changes in the entire market
- Use this information to estimate **the joint correlation matrix** of all stocks/IVOLS in the DB.
- Experiment: We study 3141 equities over 500 days. The dimensionality in column space (number of risk-factors) is N~ $3{,}000 \times 10 = 30{,}000$. The number of rows is 500.
- We have to model a correlation matrix of roughly $30K \times 30K$.
- Idea: Perform PCA on the full correlation matrix of all ``pivot returns'' (30,000). Extract significant eigenvalues and eigenvectors

The Big Correlation Matrix

correlations between risk factors of stock A

cross-correlations between risk factors of A , ZION



Each block is 10 by 10.

Marcenko-Pastur Analysis for Big Matrix

- The MP Threshold is

$$\lambda_+ \approx \left(1 + \sqrt{\frac{31410}{500}}\right)^2 = 79.67$$

- This suggests that we keep eigenvalues above 79.67 and declare that the rest is noise….

- Question : how many EVs exceed (significantly) the threshold level 79.67?

Answer: There are ~ 108 significant Evs in the options market

Top 110 Eigenvalues	s-value	$F_1(s)$
$\lambda_1 = 3742$	24843	1
$\lambda_5 = 209.27$	879.14	1
$\lambda_{10} = 143.5$	433.04	1
$\lambda_{20} = 118.19$	261.32	1
$\lambda_{40} = 102.62$	155.74	1
$\lambda_{50} = 97.40$	120.35	1
$\lambda_{70} = 90.48$	73.35	1
$\lambda_{90} = 84.56$	33.21	1
$\lambda_{107} = 80.21$	3.70	.9996
$\lambda_{108} = 80.04$	2.60	.996
$\lambda_{109} = 79.65$	-.10	.80
$\lambda_{110} = 79.41$	-1.71	.35

MP threshold

Numerically, this implies that we need to calculate only the top 108 eigenvalues/eigenvectors of the `raw' correlation matrix.

Monte Carlo Simulation*

$$X = \Sigma R^{1/2} Z$$

Where

X = vector of changes in all risk-factors (N_underlyings $\times$ 10)

$\Sigma =$ diagonal matrix of estimated EWMA standard deviations (2-day changes)

$R^{1/2}$ = square-root of the estimated correlation matrix of X (SVD, 108 top eigenvalues)

Z = vector of standardized uncorrelated random variables with suitable probability distributions (heavy tails)

10,000 random draws of Z give rise to the 10,000 scenarios for risk factors

* Slightly simplified for this presentation.

Numerical Linear Algebra

- Our first calculations of spectra and eigenvalues for the Big Correlation Matrix were hopelessly slow.
- Storage issues (get more RAM!)
- SVD calculations without care are $O(N^3)$ where N is the number of factors
- Fortunately, a series of techniques used by Data Mining and Big Data scientists can be applied to reduce computational times dramatically
- Idea: sample the column data and the row data randomly or pre-multiply data by a random matrix.

Fast SVD, low rank approximations

Let A be a ``data matrix'': m rows, n columns

$$\underset{m \times n}{\begin{pmatrix} & & \\ & A & \\ & & \end{pmatrix}} = \underset{m \times m}{\begin{pmatrix} & & \\ & U & \\ & & \end{pmatrix}} \cdot \underset{m \times n}{\begin{pmatrix} & & \\ & \Sigma & \\ & & \end{pmatrix}} \cdot \underset{n \times n}{\begin{pmatrix} & & \\ & V & \\ & & \end{pmatrix}}^T$$

We look for a good rank k approximation of A, where k<<n:

$$\underset{m \times n}{\begin{pmatrix} & & \\ & A_k & \\ & & \end{pmatrix}} = \underset{m \times k}{\begin{pmatrix} & & \\ & U_k & \\ & & \end{pmatrix}} \cdot \underset{k \times k}{\begin{pmatrix} \Sigma_k \end{pmatrix}} \cdot \underset{k \times n}{\begin{pmatrix} V_k^T \end{pmatrix}}$$

The best rank k approximation uses the top k eigenvectors of the matrix AA^T.
(The approximation is in the sense of the L2 norm for matrices.)

Rokhlin, Zlam, and Tygert, 2009

- For SVD, approximate the optimal rank-k approximation by multiplying the data by a random $n \times k$ matrix, G (i.i.d. Uniform(0,1)), and performing SVD

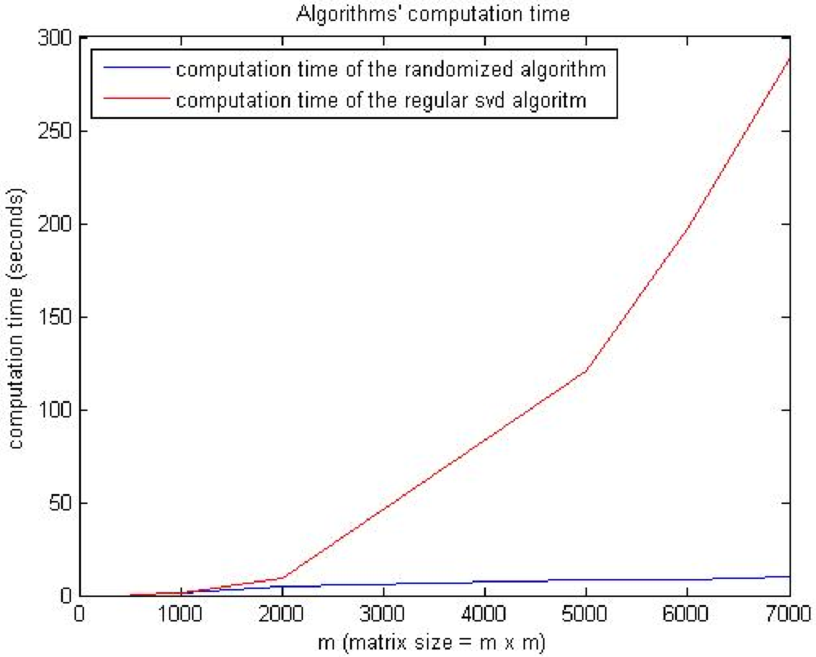
$$A \to G \times A$$

- Pre-multiplying has the effect of sampling the data (our interpretation) and preserves the correlation matrix of the market. The advantage is that we work with a much smaller matrix.

- Using appropriate choice of k, according to the rank of m (108) , leads to very small errors in the spectrum. (Hence accurate reconstruction of true correlation).

Rokhlin, Zlam, and Tygert, 2009 : Fast SVD

- For a data matrix, approximating the optimal rank k approximation (top EVECS /EVALS) by multiplying the data by a random rank k matrix G (i.i.d. Uniform(0,1)).

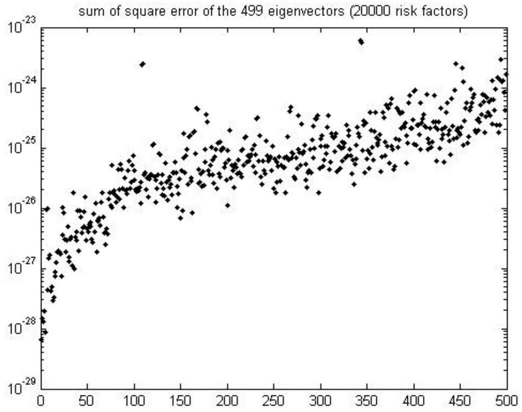


Picture source: Finance Concepts, 2014

All available stocks in OptionMetrics +pivots

Data size: N=31,837, k=500
Computational time, randomized SVD=41 secs
Computational time, regular SVD = too long to observe

For comparison purposes, we also did a 20,000 risk factor matrix.
Data size: N=20,000, k=500
Computational time, randomized SVD=17 secs
Computational time, regular SVD = 4520 secs



Comparison of approximate
and actual evs for the top 500
Eigenvalues give very small errors of order
$10^{-28} - 10^{-23}$

Source: Finance Concepts, 2014

Numerical implementation issues

- Due to fast SVD algorithm, the computation of the square-root of the correlation matrix is very fast.

  The main bottlenecks are:

- Computing the initial 9-pivots for each surface from closing data

- Repricing all the options with BS under the 10,000 risk scenarios (10 billion BS calculations)

Case Study III:
Monte-Carlo Framework for Margining Credit Default Swaps (OTC derivatives CCP) (2013/2014)

Spread risk
Correlation Risk
Jump-to-default risk
Jump-to-health risk
Liquidity risk*
Interest rate risk*

Description of the Model : Single Name CDS and CDS Index Factors

- Risk-factors are spreads' log changes
  - Single Name CDS : Par spreads at fixed benchmark tenors (1, 3, 5, 7, 10 years)
  - CDS Indices : Par spreads of synthetic OTR_{-k} (k=0,1,…) indices (fixed maturity) interpolated at fixed benchmark tenors to preserve stationarity

- Salient characteristics of risk factors
  - Autocorrelations : non-uniform across entities and tenors
  - Heteroscedasticity
  - Varying degrees of heavy tails : observed, but statistically weak asymmetry
  - Stable average correlations
    - Single name – Single name
    - Single name – Index
    - Index – Index
  - Strong correlations across tenors
  - Strong dependence across on-the-run and off-the-run indices (same index family)
  - Index – constituent basis
  - Breakdown of correlations in distressed markets
  - Jumps: defaults and drastic improvements in credit quality

Autoregressive and Heteroscedastic Nature of Risk-factor distributions

- For a given tenor τ and name i (SN or Index):

$$R_{i,\tau}(t) = a_{i,\tau}(t)R_{i,\tau}(t-1) + \sigma_{i,\tau}(t)\varepsilon_{i,\tau}(t)$$

AR-1

$R_i(k,t)$ is a daily log-return of the risk factor par spreads

$$R_{i,\tau}(t) = \ln CDS_{i,\tau}(t) \; - \ln CDS_{i,\tau}(t-1)$$

$a_{i,\tau}(t)$ is an autoregressive AR(1) coefficient for the **autocorrelation** observed in $R_{i,\tau}(t)$

$$a_{i,\tau}(t) = \frac{1}{756}\sum_{s=1}^{756} R_{i,\tau}(t-s+1) * R_{i,\tau}(t-s)$$

$\sigma_{i,\tau}(t)$ is a volatility scale factor, defined as the **EWMA standard deviation of the residuals of AR(1) model**

$$\sigma_{i,\tau}(t) = \frac{1}{\sum_{s=1}^{252}\lambda^{s-1}}\sum_{s=1}^{252}\lambda^{s-1}\left[X_{i,\tau}(t-s)\right]^2$$

where $X_{i,\tau}(t)$ is the deautocorrelated daily log-return : $X_{i,\tau}(t) = R_{i,\tau}(t) - a_{i,\tau}(t)R_{i,\tau}(t-1)$

Correlation Modeling

- $\mathcal{C}(t)$ is estimated from T transformed residuals for M risk factors, with $T = 504$ to represent two years of historical data and M is in the order of 1000s
- $\mathcal{C}(t)$ is therefore positive semi-definite and is cleaned for spurious correlations and estimation biases
- Cleaning is based Principal Component Analysis (PCA) and Random Matrix Theory (RMT)

$$\mathcal{C} = \Omega^{-1} \begin{pmatrix} \lambda_1 & 0 & 0 & \cdots & 0 \\ 0 & \lambda_2 & 0 & \dots & 0 \\ 0 & 0 & \lambda_3 & \ddots & \vdots \\ \vdots & \vdots & \ddots & \ddots & 0 \\ 0 & 0 & \cdots & 0 & \lambda_M \end{pmatrix} \Omega$$

- $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_M$ are the eigenvalues of $\mathcal{C}$ where $\lambda_j = 0$ for $j = M+1, \dots, T$
- $\lambda \in [\lambda^-, \lambda^+]$ are eigenvalues of $\mathcal{C}$ which cannot be distinguished from 1 statistically,

  where $\lambda^- = \left(1 - \sqrt{\frac{M}{T}}\right)^2$ and $\lambda^+ = \left(1 + \sqrt{\frac{M}{T}}\right)^2$ are RMT based eigenvalue thresholds

Extreme (``stressed”) Correlations Scenarios

- $\bar{\sigma}_{i,\tau}(t)$ is a long-run volatility component which introduces countercyclicality in individual risk factor variations :

$$\bar{\sigma}_{i,\tau}(t) = \frac{1}{N_{i,\tau}(t)} \sum_{s=0}^{N_{i,\tau}(t)-1} R_{i,\tau}(t-s)^2$$

- $\bar{a}_{i,\tau}(t) = \frac{1}{N_{i,\tau}-1} \sum_{s=1}^{N_{i,\tau}-1} R_{i,\tau}(t-s+1) * R_{i,\tau}(t-s)$ is a long-run autocorrelation estimate which introduces countercyclicality for scaling daily volatility to margin period of risk

- $\mathcal{C}^{low}$ and $\mathcal{C}^{high}$ are two correlation matrices which add countercyclicality to modeling of the joint movement of risk factors

$$\mathcal{C}^{low} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & \ddots & \ddots & \ddots & \ddots & \ddots \\ 0 & \ddots & 1 & \ddots & \ddots & \ddots \\ 0 & \ddots & \ddots & 1 & \bar{\rho}_{I,I} & \bar{\rho}_{I,I} \\ 0 & \ddots & \ddots & \bar{\rho}_{I,I} & \ddots & \ddots \\ 0 & \ddots & \ddots & \bar{\rho}_{I,I} & \ddots & 1 \end{pmatrix} \text{ and } \mathcal{C}^{high} = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & \ddots & \ddots & \ddots & \ddots \\ 1 & \ddots & \ddots & \ddots & \ddots \\ 1 & \ddots & \ddots & \ddots & \ddots \\ 1 & \ddots & \ddots & \ddots & \ddots \end{pmatrix}$$

Modeling the joint distribution of all risk factors

- Each risk factor is modeled as a symmetric t-distribution with $\upsilon_{i,\tau}$ degrees of freedom
- The degree of freedom parameter is estimated by minimizing the Anderson-Darling statistic for the conditional residuals: $\varepsilon_{i,\tau}(t) = \frac{X_{i,\tau}(t)}{\sigma_{i,\tau}(t)}$

$$AD_{i,\tau}(\nu, t\,)$$
$$= -N_{i,\tau}(t) - \sum_{j=1}^{N_{i,\tau}(t)} \frac{2j-1}{N_{i,\tau}(t)} \left[\ln t_\nu \left(\frac{\nu}{\nu-2} \frac{\varepsilon_{i,\tau}{}^{[j]} - \mu(\varepsilon_{i,\tau}).}{std(\varepsilon_{i,\tau})} \right) + \ln \left(1 - t_\nu \left(\frac{\nu}{\nu-2} \frac{\varepsilon_{i,\tau}{}^{[j]} - \mu(\varepsilon_{i,\tau}).}{std(\varepsilon_{i,\tau})} \right) \right) \right]$$

$$\hat{\nu}_{i,\tau}(t) = \underset{\nu}{\operatorname{argmin}}\, AD_{i,\tau}(\nu, t\,)$$

where $N_{i,\tau}(t)$ is the number of all historical data available for risk factor (i,τ) at time t

$\varepsilon_{i,\tau}{}^{[j]}$ are the ordered conditional residuals

- In the t-copula model, the correlation matrix estimate $\mathcal{C}(t)$ is the correlation matrix of transformed conditional residuals

$$\epsilon_{i,\tau}(t) = t^{\nu_C{}^{-1}} \left(t_{\hat{\nu}_{i,\tau}(t)} \left(\sqrt{\frac{\hat{\nu}_{i,\tau}(t)}{\hat{\nu}_{i,\tau}(t) - 2}}\, \varepsilon_{i,\tau}(t) \right) \right)$$

Scenario Generation

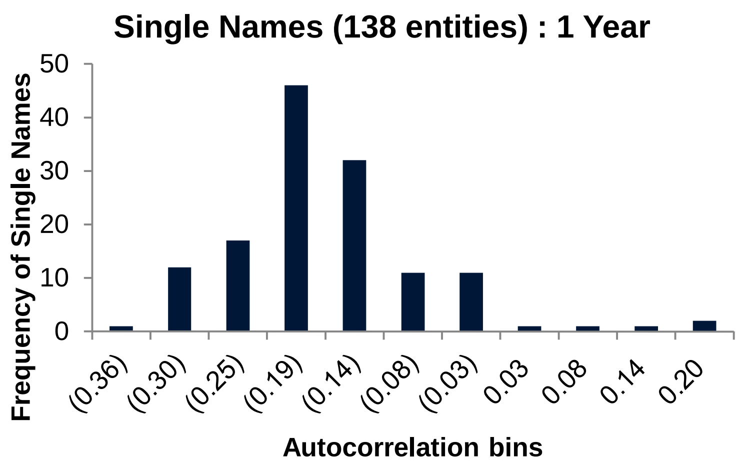
- For each Monte Carlo scenario $j = 1, \dots, N_{MC}$, the spread shock to a given tenor τ of name i (SN or Index) is given by

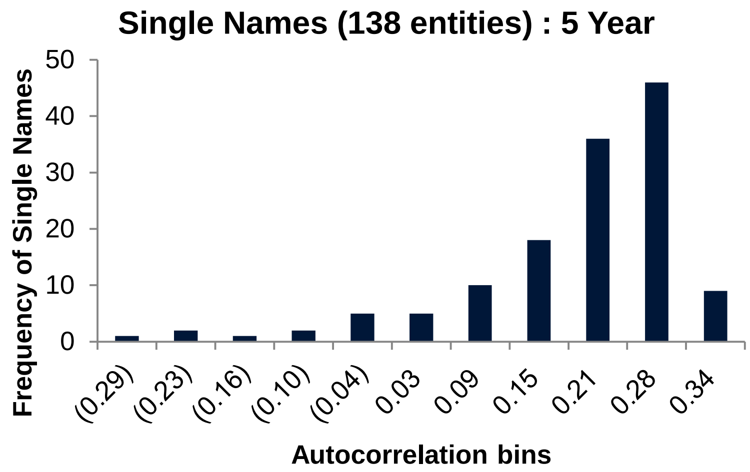
$$R_{i,\tau}{}^{(j)}(t+n) = \left[\hat{\sigma}_{i,\tau}(t+1) \vee \bar{\sigma}_{i,\tau}(t)\right] \sqrt{n + 2(n-1)\left(a_{i,\tau}(t) \vee \bar{a}_{i,\tau}(t) \vee 0\right)}\, \xi_{i,\tau}{}^{(j)}$$

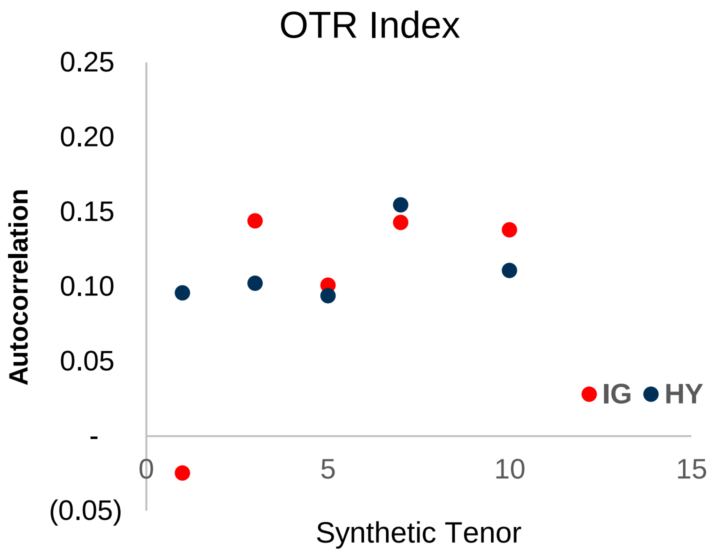
where

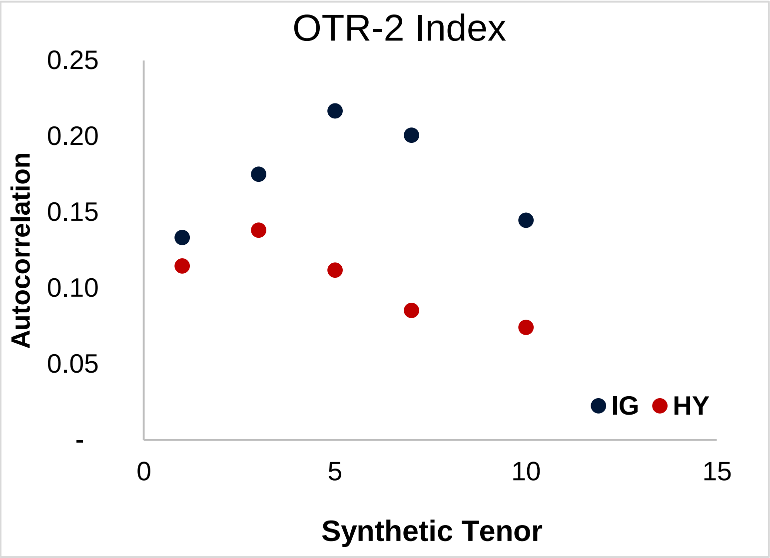
- $\xi_{i,\tau}{}^{(j)} \sim \sqrt{\frac{\hat{\nu}_{i,\tau}-2}{\hat{\nu}_{i,\tau}}}\, \boldsymbol{t}_{\hat{\nu}_{i,\tau}}{}^{-1}\left(\mathrm{Rank}\left[z_{i,\tau}{}^{(j)}\right]\right)$ where $z_{i,\tau}{}^{(j)} \sim \boldsymbol{t}_{\nu_c}(\mathcal{C})$ is a simulated multivariate Student-t variable with correlation matrix $\mathcal{C}$ and a common degree of freedom of t_{ν_c}
- $\hat{\sigma}_{i,\tau}(t+1)$ is the EWMA volatility forecast at margin/stress date t
  - For margin calculations : $\hat{\sigma}_{i,\tau}(t+1) = \sigma_{i,\tau}(t+1)$
  - For stress calculations : $\hat{\sigma}_{i,\tau}(t+1) = \max_{s \le t} \sigma_{i,\tau}(s+1)$
- $\mathcal{C}$ is set to $\mathcal{C}_0(t)$, $\mathcal{C}^{low}$ and $\mathcal{C}^{high}$ for base, basis and systematic margin requirement calculations, respectively
- $\nu_c = 3$ and $N_{MC} = 10{,}000$

Non-Uniform Autocorrelations Across Obligors, Tenors: 2013/6/21

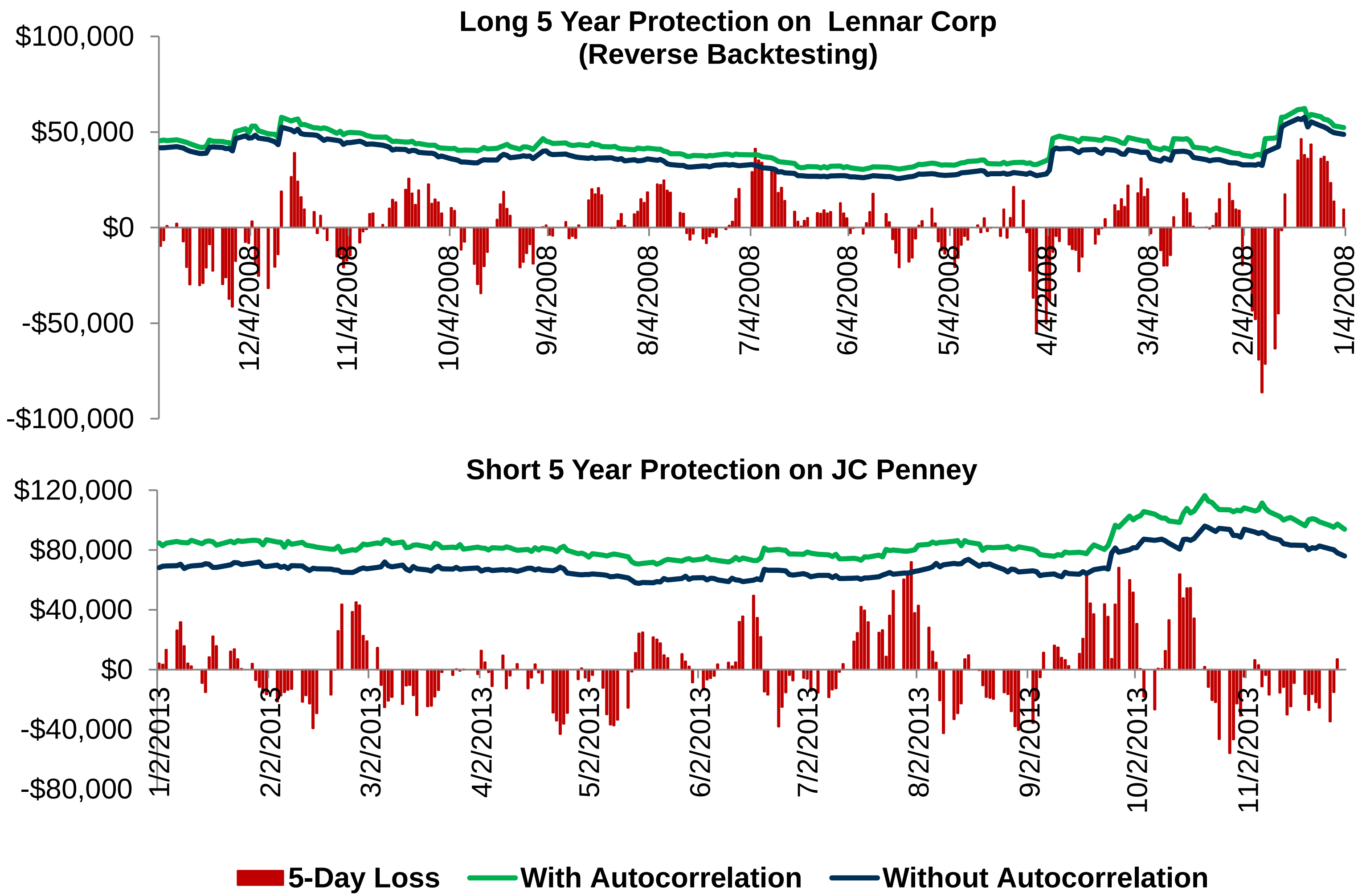








Effect of Autocorrelation Adjustment (Margin Period of Risk Volatility Scaling) on Spread Risk Requirement



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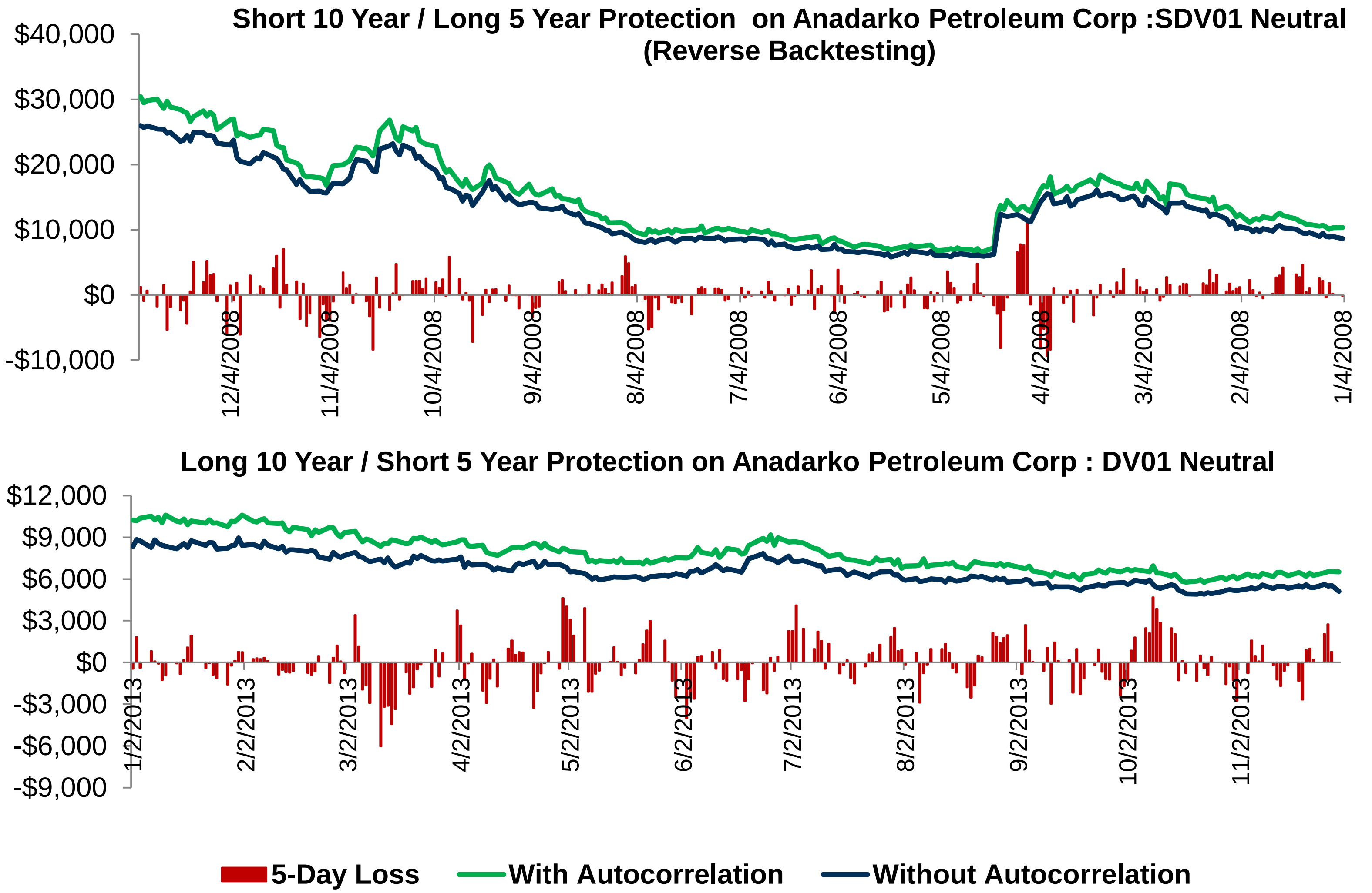
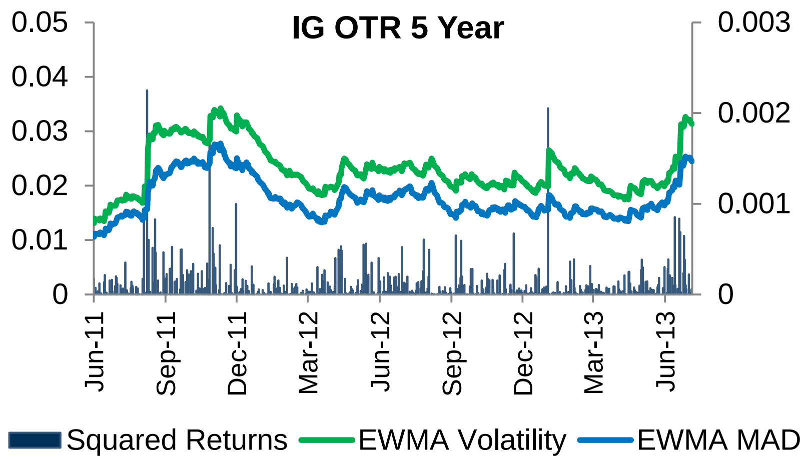
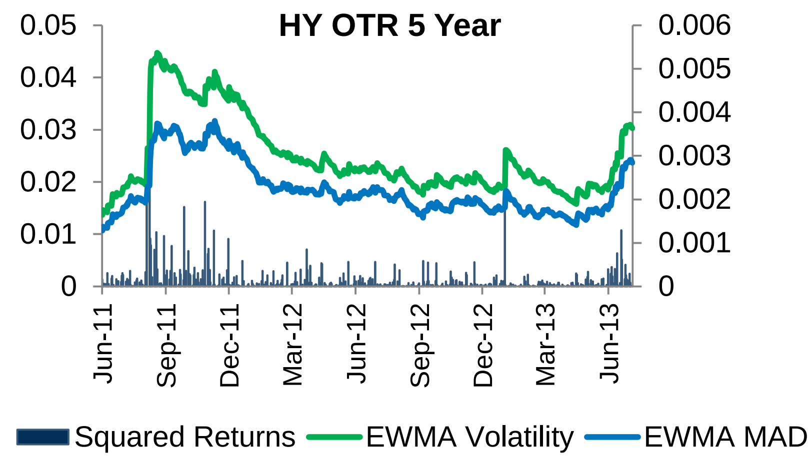
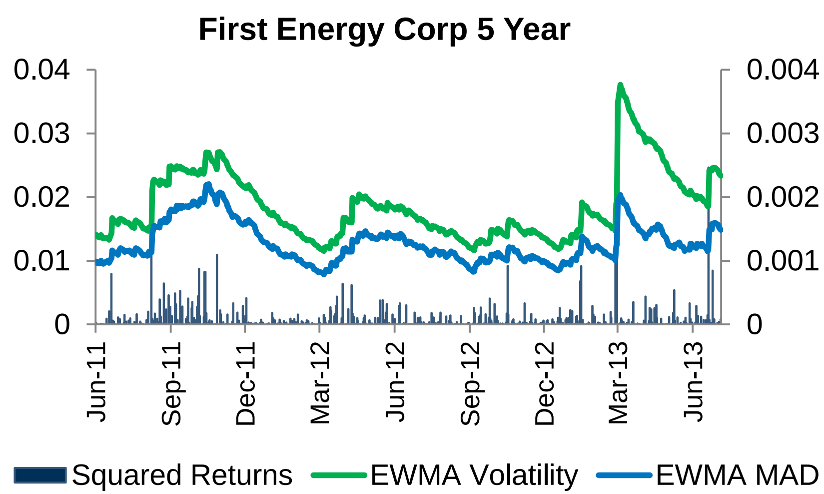
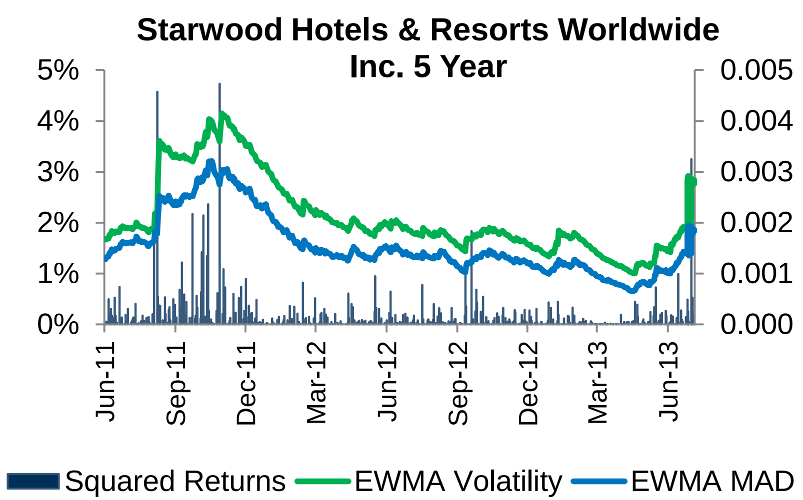


Heteroscedasticity, EWMA Estimate of Volatility and EWMA Mean Absolute Deviation (MAD)

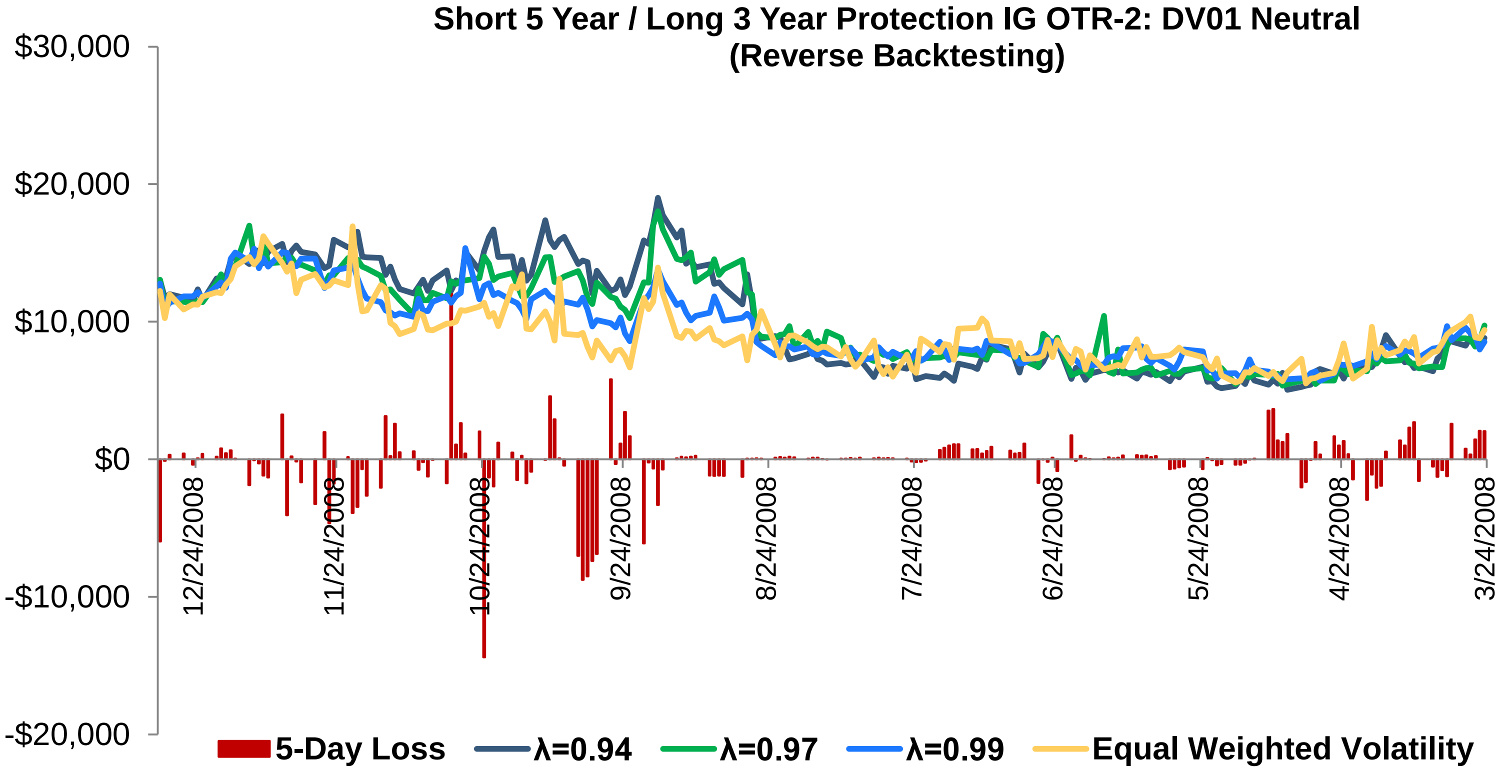




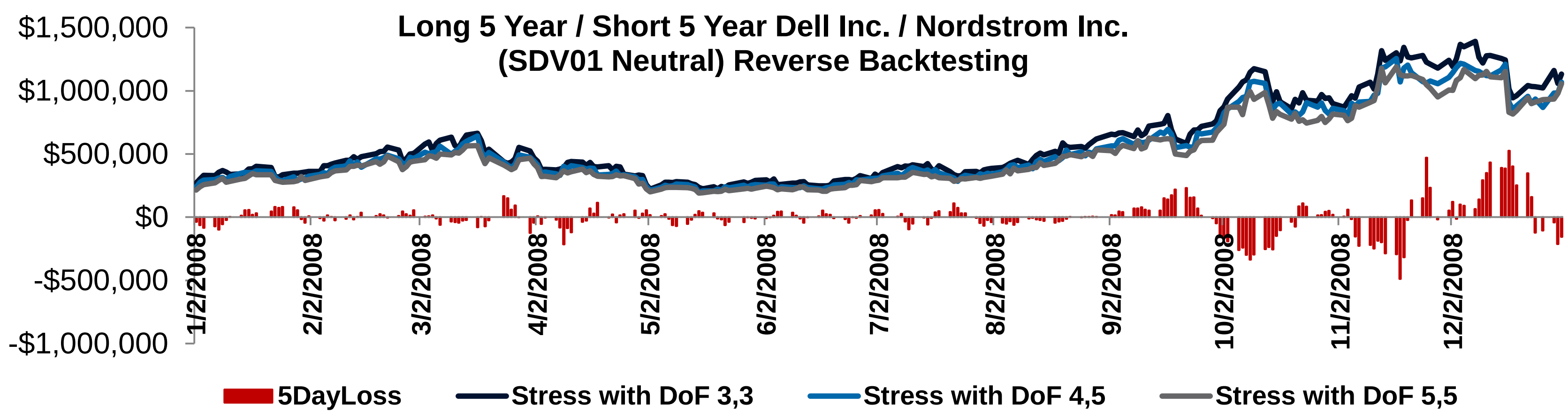


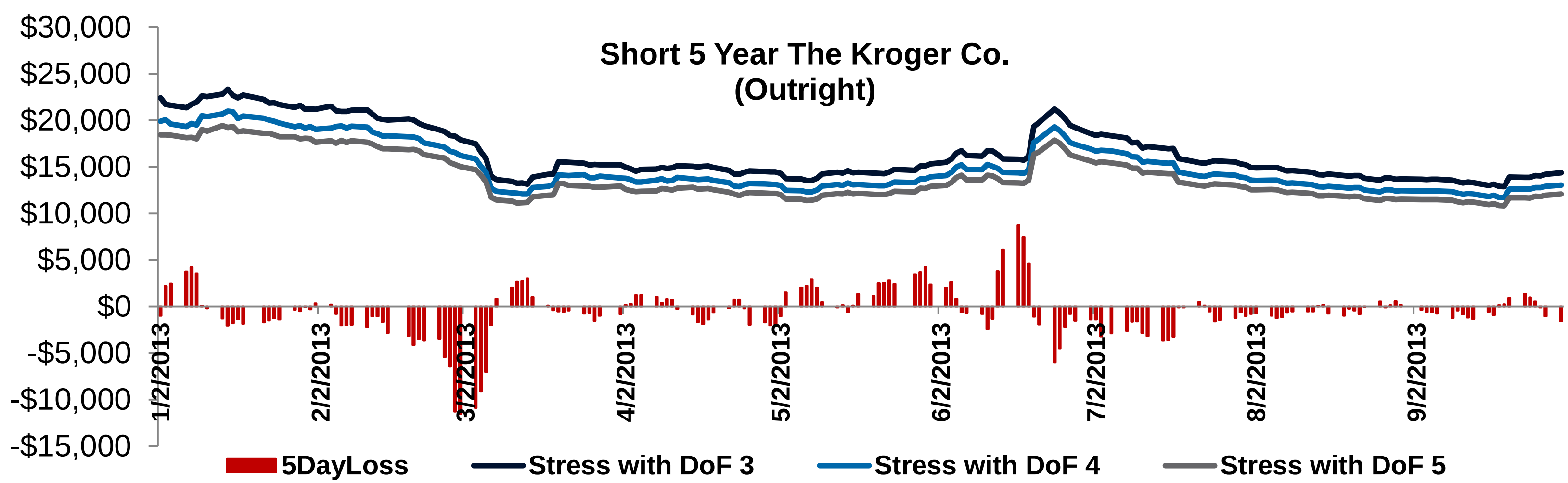


Effect of EWMA Smoothing Constant on Spread Risk Requirement

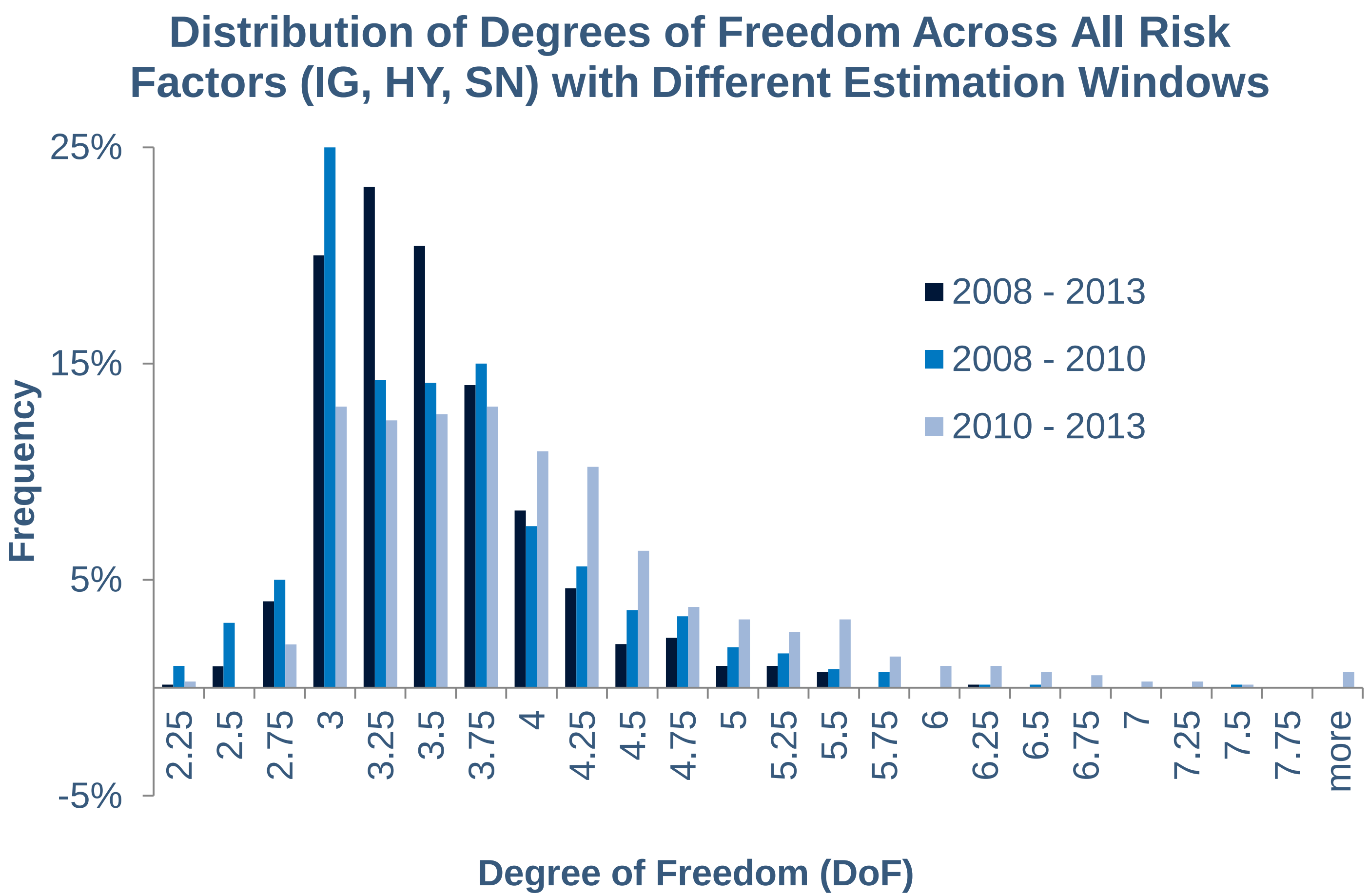


Impact of Different Degree of Freedom on Margin/Stress Spread Risk Requirement





Varying Degrees of Heavy Tails



Symmetric Tail Dependence (Copula Symmetry)

- The (a)symmetric tail dependence of a pair of risk factors, X and Y, can be tested by
  - Calibrating a Student-t distribution on each risk factor to get degree of freedom parameter estimates ν_X and ν_y
  - Applying to each risk factor observation, X_i and Y_i $(i = 1, \dots, n)$, the corresponding cumulative distribution function to get a sample of uniform observations in [0,1]
  - Testing the null hypothesis that

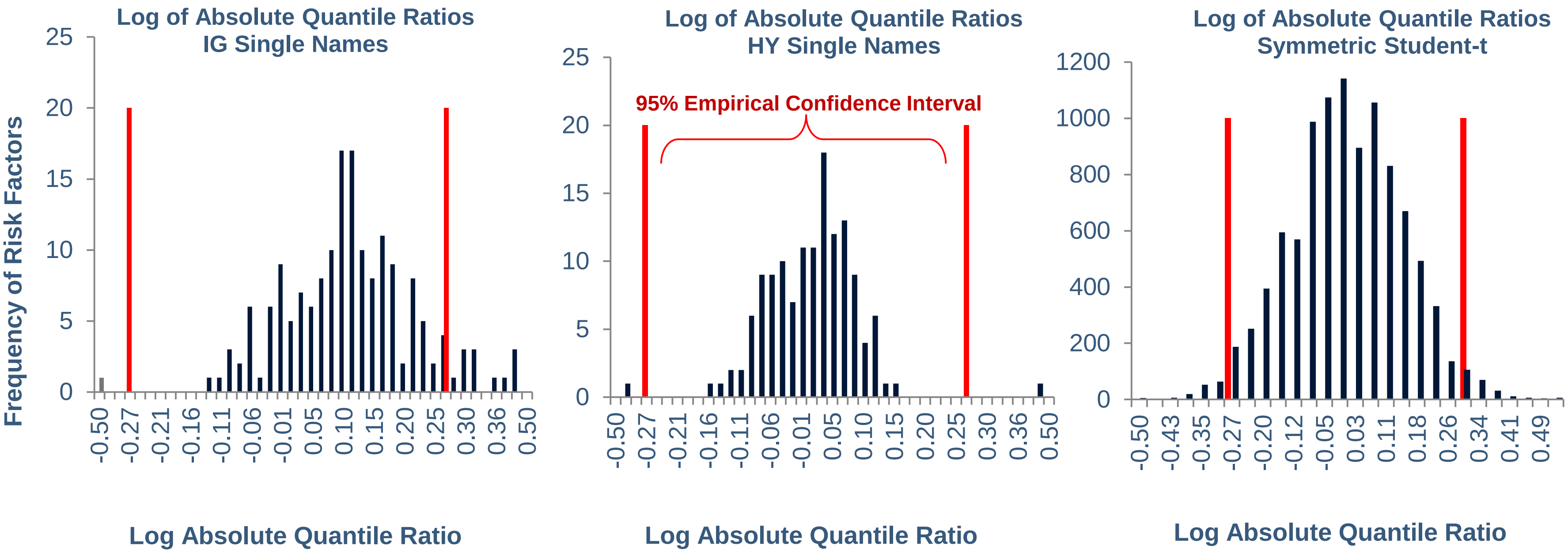
$$H_0 : C(u,w) = C(w,u) \quad \forall (u,w) \in [0,1]^2$$

where C is the empirical Copula of the joint distribution of the pair of risk factors

$$C(u,w) = \frac{1}{n}\sum_{i=1}^{n} 1\left\{t_{\nu_X}(X_i) \le u, t_{\nu_Y}(Y_i) \le w\right\} \quad \forall (u,w) \in [0,1]^2$$

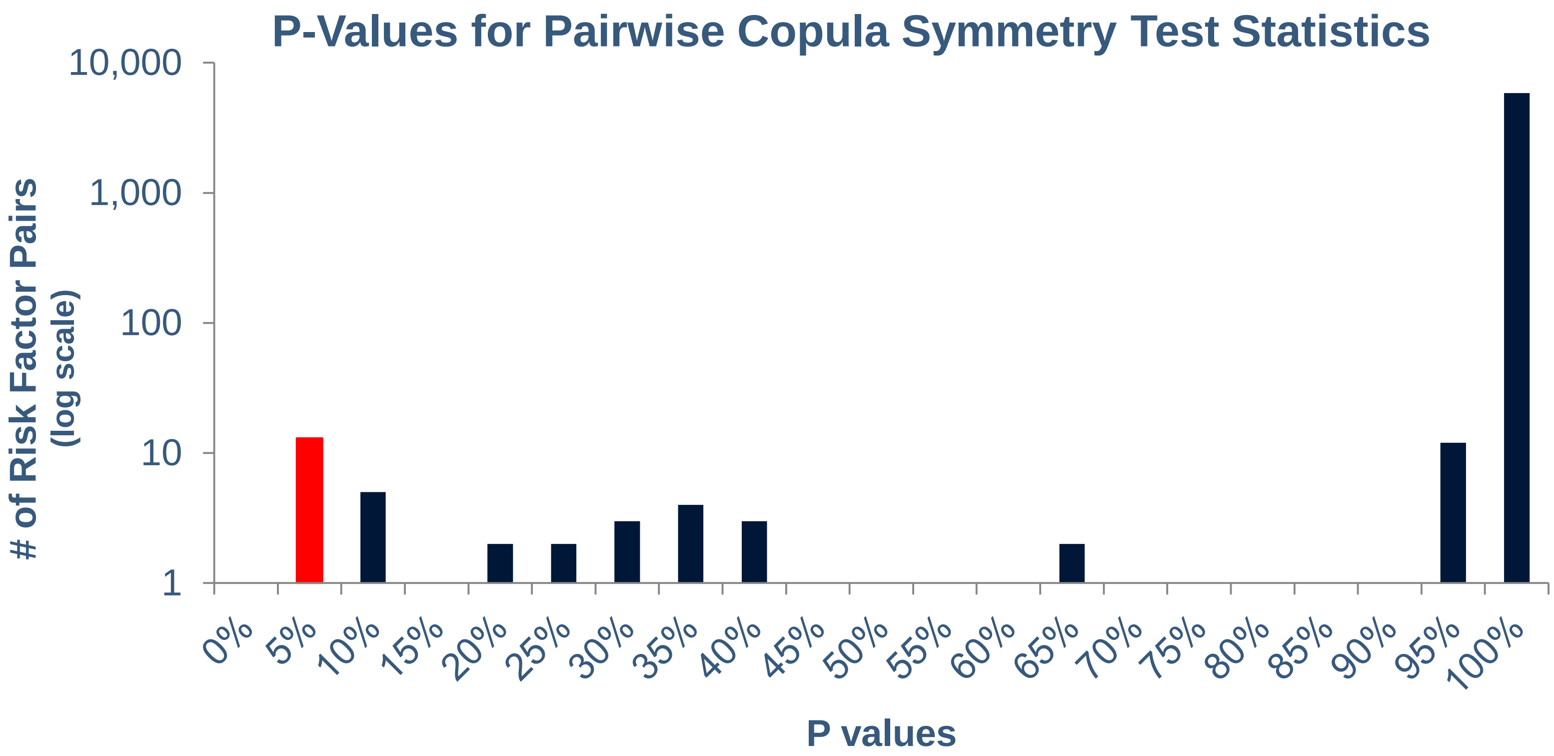
Testing Asymmetry in Tail Behavior for Risk-factor distribution

- Use the log ratio of the absolute value of 99% and 1% quantiles as the test statistic
- Benchmark with 10,000 samples of 1448 observations from a symmetric Student-t distribution (3 d.o.f.)
- Symmetry can be rejected with 95% confidence level for only 12/170 IG names and 3/135 HY names



Symmetric Tail Dependence (Copula Symmetry)

- Among the 5409 pairs of risk factors tested for proof of copula asymmetry, the empirical copula symmetry hypothesis cannot be rejected for 99.76 % of pairs



Risk Factor Scenario Generation (Monte Carlo Simulation)

Tail Parameter Estimate				
$\hat{\nu}_{1,1yr}(t)$	…	$\hat{\nu}_{1,10yr}(t)$	$\hat{\nu}_{2,1yr}(t)$	…

$t_{\nu_c}(\mathcal{C})$

$\xi_{1,1yr}^{(1)}$	…	$\xi_{1,10yr}^{(1)}$	$\xi_{2,1yr}^{(1)}$	…
$\xi_{1,1yr}^{(2)}$	…	$\xi_{1,10yr}^{(2)}$	$\xi_{2,1yr}^{(2)}$	…
$\xi_{1,1yr}^{(3)}$	…	$\xi_{1,10yr}^{(3)}$	$\xi_{2,1yr}^{(3)}$	…
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
$\xi_{i,1yr}^{(N_{MC})}$	…	$\xi_{i,10yr}^{(N_{MC})}$	$\xi_{2,1yr}^{(N_{MC})}$	…

Autocorrelation Estimate				
$\hat{a}_{1,1yr}(t)$	…	$\hat{a}_{1,10yr}(t)$	$\hat{a}_{2,1yr}(t)$	…

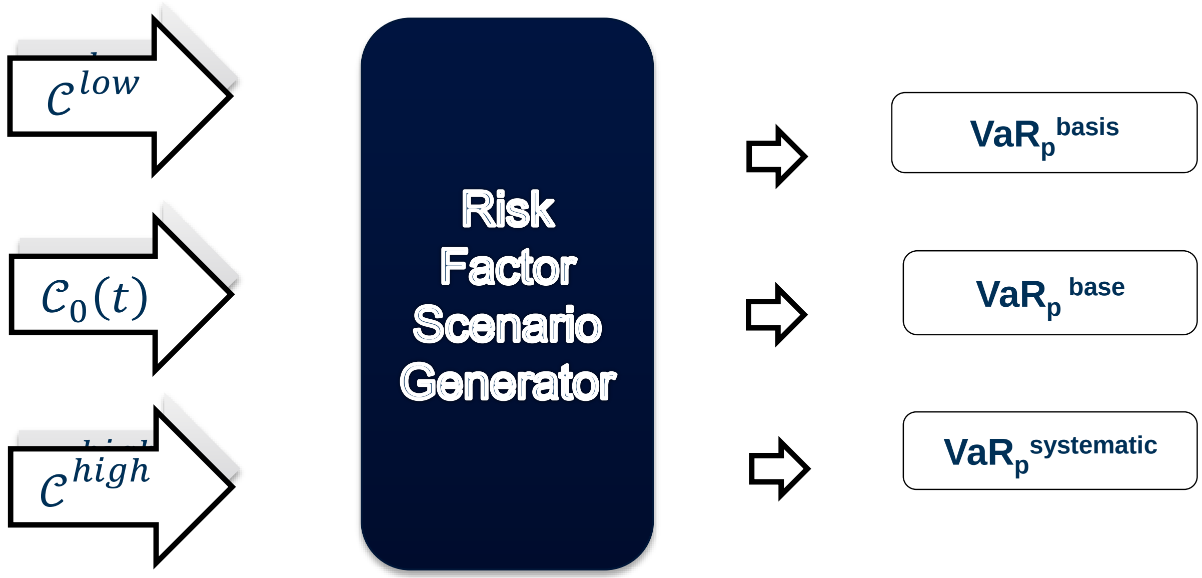
Long-run Autocorrelation Estimate				
$\bar{a}_{1,1yr}(t)$	…	$\bar{a}_{1,10yr}(t)$	$\bar{a}_{2,1yr}(t)$	…

$R_{1,1yr}^{(1)}$	…	$R_{1,10yr}^{(1)}$	$R_{2,1yr}^{(1)}$	…
$R_{1,1yr}^{(2)}$	…	$R_{1,10yr}^{(2)}$	$R_{2,1yr}^{(2)}$	…
$R_{1,1yr}^{(3)}$	…	$R_{1,10yr}^{(3)}$	$R_{2,1yr}^{(3)}$	…
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
$R_{i,1yr}^{(N_{MC})}$	…	$R_{i,10yr}^{(N_{MC})}$	$R_{2,1yr}^{(N_{MC})}$	…

Ewma Volatility Forecast				
$\hat{\sigma}_{1,1yr}(t+1)$	…	$\hat{\sigma}_{1,10yr}(t+1)$	$\hat{\sigma}_{2,1yr}(t+1)$	…

Long-run Volatility Estimate				
$\bar{\sigma}_{1,1yr}(t)$	…	$\bar{\sigma}_{1,10yr}(t)$	$\bar{\sigma}_{2,1yr}(t)$	…

Total Spread Risk Requirement: Base, Basis, Systematic Risk Requirements



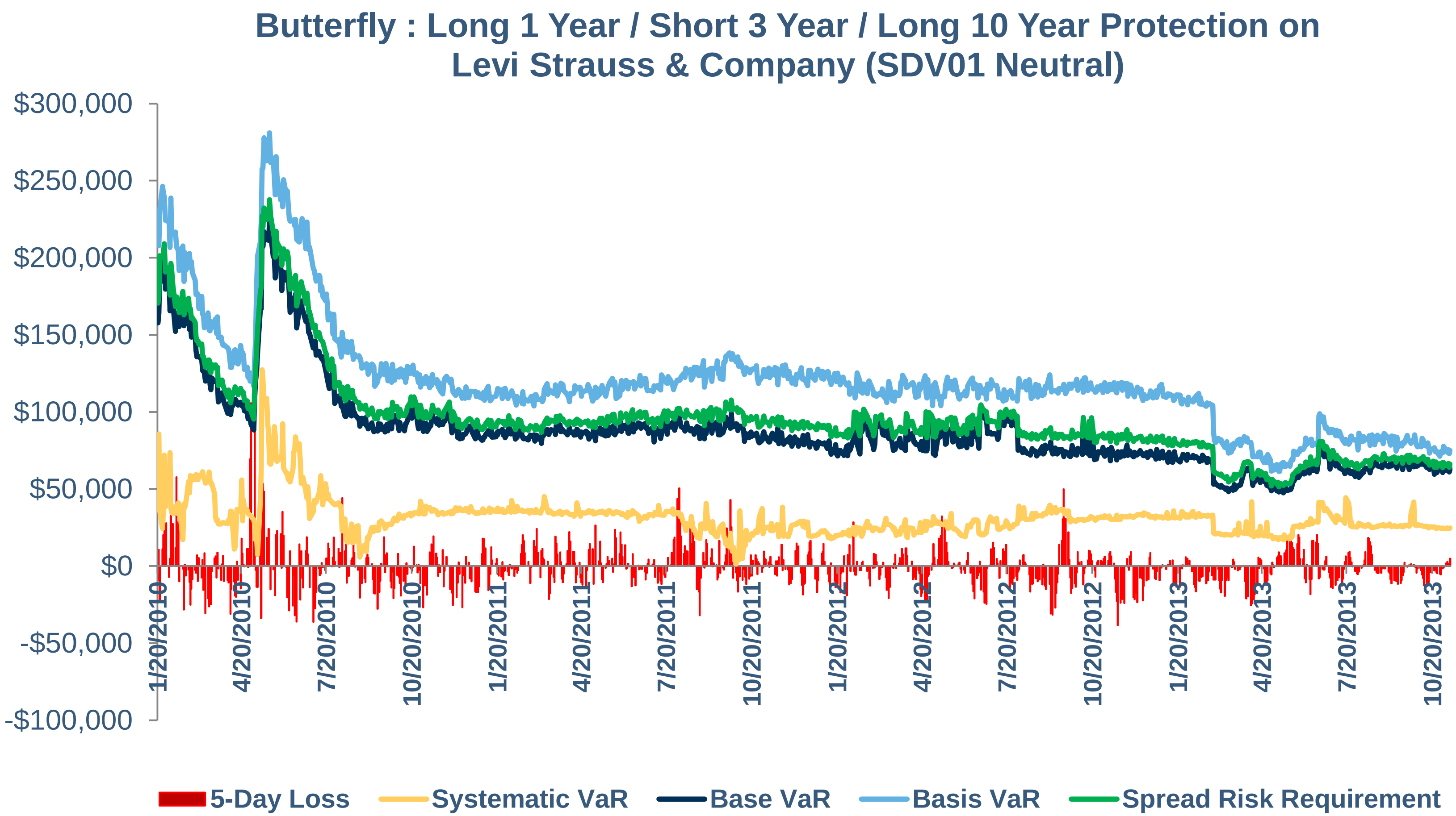
$\text{VaR}_p^{\text{base}}$

$\text{VaR}_p^{\text{basis}} - \text{VaR}_p^{\text{base}}$

$\text{VaR}_p^{\text{systematic}} - \text{VaR}_p^{\text{base}}$

Total Spread Risk Requirement = **Base Spread Risk Requirement** + α **max** { **Basis Risk Requirement** , **Systematic Risk Requirement** }

Impact of High, Low, Base Correlation Matrix on Spread Risk Requirement : Basis Exposure

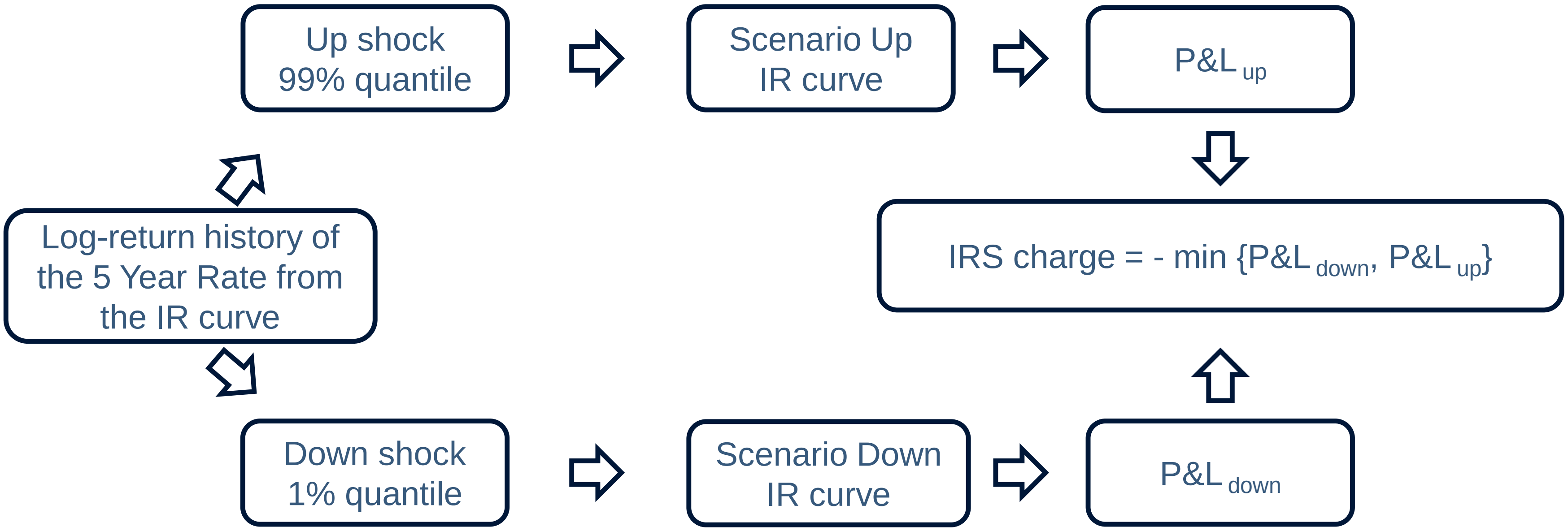


Jump-to-Default (JTD) and Jump-to-Health Risk Requirements

- JTD and JTH risk requirements are add-on risk charges to cover for the default and drastic improvement in credit quality of one entity
- Credit entities are removed one at a time from the portfolio
- Base spread requirement of the remaining portfolio is re-calculated
  - For JTD, index position scenario P&L's are reduced by a ratio of 1 / #(index constituents)
  - For JTH, index position scenario P&L's are not adjusted
  - Each spread scenario P&L is added a JTD and JTH P&L for the removed entity
  - For JTD: (Total Single Name Notional with Index Decomposition) x (RR – Current Price)
  - For JTH: (Single Name Notional) x (Price @ Low Percentile (%0.5) Spread of High Correlation Scenarios – Current Price)
- JTD and JTH quantiles are calculated from the new scenario P&L's: for each entity k, $VaR_p^{idio,k}$
- The final JTD and JTH risk requirements are calculated as $\max_k\{ VaR_p^{JTD,k} \} - VaR_p$ and $\max_k\{ VaR_p^{JTH,k} \} - VaR_p$, respectively

Interest Rate Sensitivity Charge

- This charge covers losses due to changes in interest rate term structure,
- The sensitivity is mainly to the parallel upward and downward shifts of the interest rate (IR) curve



Stress Extension for GF calculations

- ❑ The stress model is an extension of the margin model
- ❑ The stress spread risk requirement is calculated from a higher percentile of the P&L distribution across scenarios: VaR_q where q = %99.75
- ❑ The number of obligors considered for JTD is two instead of 1
- ❑ The JTH spread is computed from a lower (0.05%) percentile of the high correlation scenarios
- ❑ The spread risk requirement is the maximum of base, basis and systematic stress VaR : $\alpha_{Stress} = 1$
- ❑ The interest rate risk requirement is computed from %0.25 and %99.75 percentile of historical log changes of the 5 year point on the IR curve

Model Parameters and Calibration : Summary for Margin and Stress Calculations

Item	MARGIN		STRESS	
Parameter	**Calibration**	**Value**	**Calibration**	**Value**
JTH Quantile	High Correlation Scenarios	0.50%	High Correlation Scenarios	0.05%
VaR Quantile	10,000 Scenarios	99.00%	10,000 Scenarios	99.75%
Copula Student-t DoF		3		3
Risk Factor Student-t DoF	[$t_{0,i}$, t_M]		[$t_{0.i}$, t_M]	
EWMA Scaling Parameter		0.97		0.97
EWMA Volatility	[t - 252 , t-1]		[t - 252 , t-1]	
EWMA Volatility Forecast	[t_M -252 , t_M]		[$t_{0,i}$, t_M]	
Countercyclical Volatility	[$t_{0,i}$, t_M]		[$t_{0,i}$, t_M]	
Historical Correlation Matrix	[t_M - 504 , t_M]		[t_M - 504 , t_M]	
Low Correlation Matrix		0 (Ind/Ind : 0.5)		0 (Ind/Ind : 0.5)
High Correlation Matrix		1		1
Autocorrelation	[t_M - 504 , t_M]		[t_M - 504 , t_M]	
Countercyclical Autocorrelation	[$t_{0,i}$, t_M]		[$t_{0,i}$, t_M]	
Number of JTD/JTH Entities		1 / 1		2 / 1
Minimum Recovery Rate (JTD)	[$t_{0,i}$, t_M]		[$t_{0,i}$, t_M]	
Correlation Charge Factor		0.25		1
Interest Rate Quantile	[$t_{0,i}$ - 1260 , t_M]	1% / 99%	[$t_{0,i}$ - 1260 , t_M]	0.25% / 99.75%

t_M : Margin/Stress date **$t_{0,i}$: Earliest date which has market data for risk factor *i***

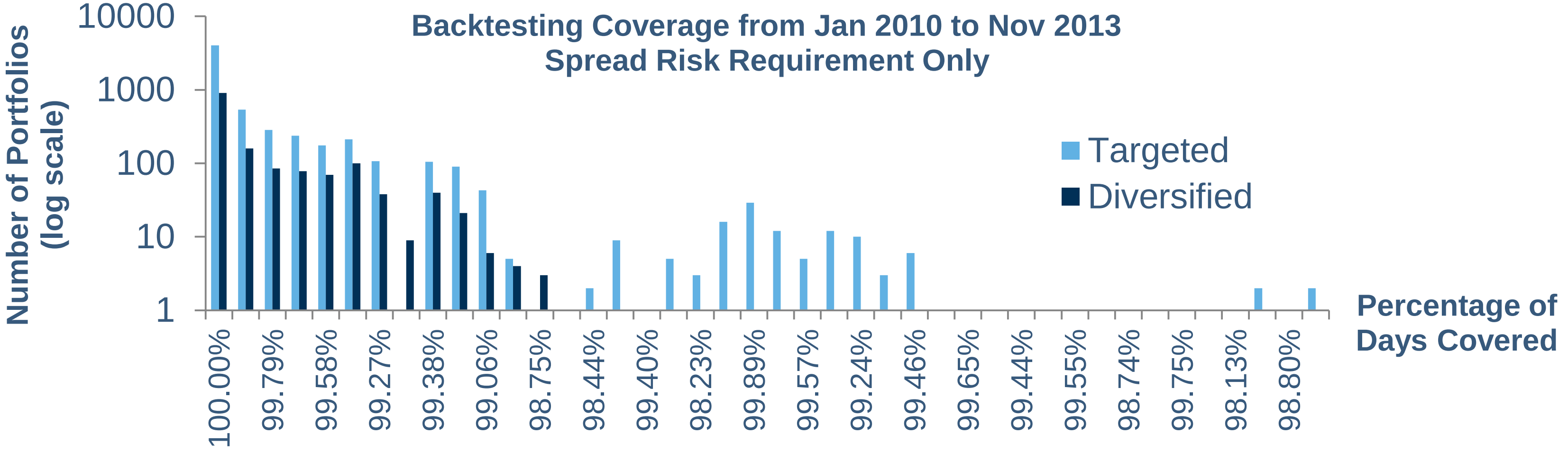
Backtesting Portfolios and Strategies

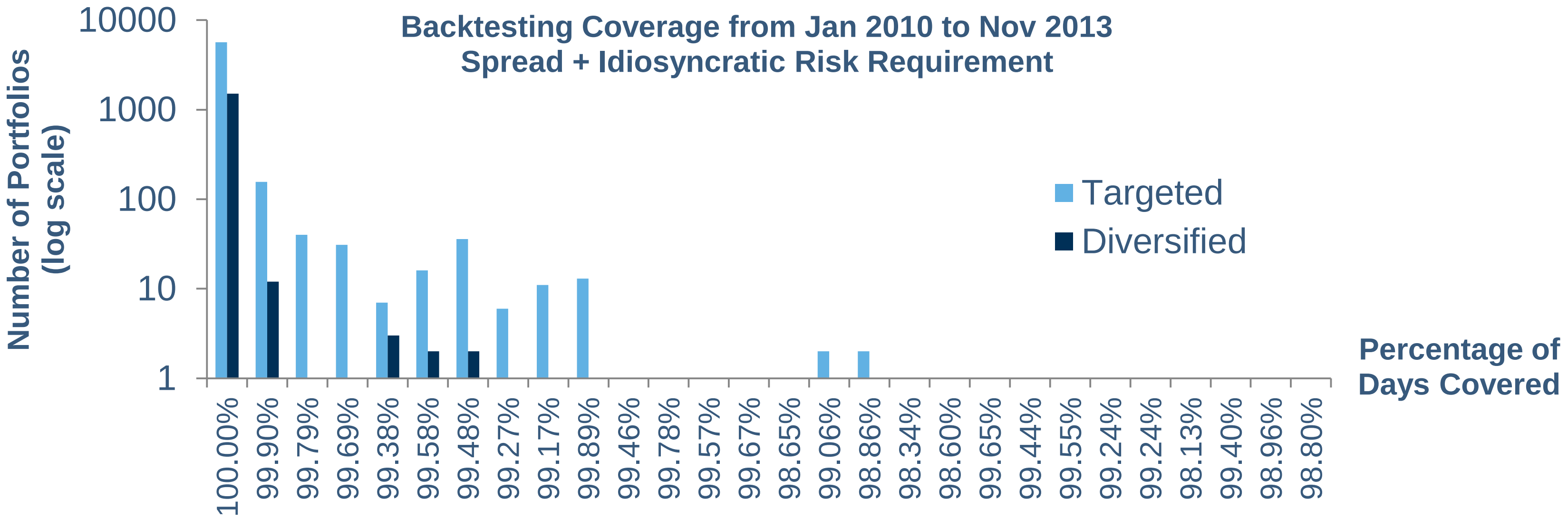
Directional | DV01 Zero | SDV01 Zero

Targeted Portfolios			
Strategy	**Examples**		
	(Buy, Sell)	(Sell, Buy)	(Buy, Sell)
Curve	IG 5	IG 10	
	HY 5	HY 10	
	SN 5	SN 10	
	IG 1	IG 5	IG 10
Pair	IG 5	HY 5	
	SN 5	HY 5	
	IG 5	SN 5	
	SN_i 5	SN_j 5	
Roll	IG OTR 5	IG OTR-n 5	
	HY OTR 5	HY OTR-n 5	
Pair x Curve	IG 5	HY 10	

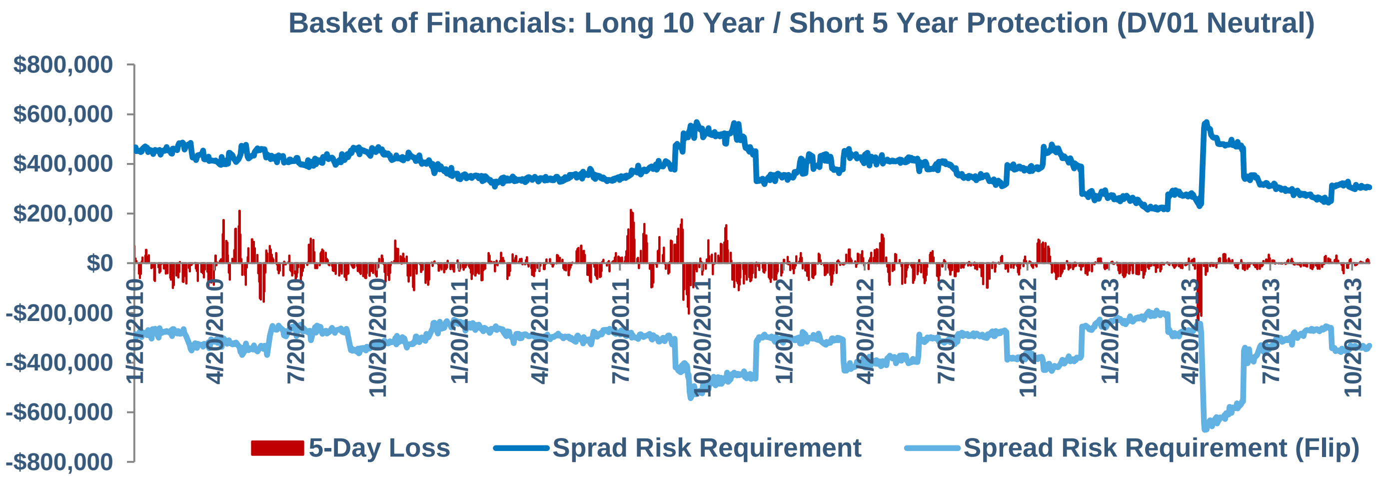
Diversified Portfolios			
Strategy	**Examples**		
	(Buy, Sell)	(Sell, Buy)	(Buy, Sell)
Index Arbitrage	IG 5	IG Constituents 5	
Basis	IG 5	Financials 5	
	High Spread 5	Low Spread 5	
Curve	Financials 5	Financials 10	
	Technology 1	Technology 5	Technology 10
Sector	Industrials 5	Consumer Goods 5	
Basis x Curve	IG 10	IG Constituents 5	
Sector x Curve	Financials 5	Consumer Services 10	

Back-testing Results on 5,973 Targeted and 1,527 Diversified Portfolios (7,500 Total) : Coverage

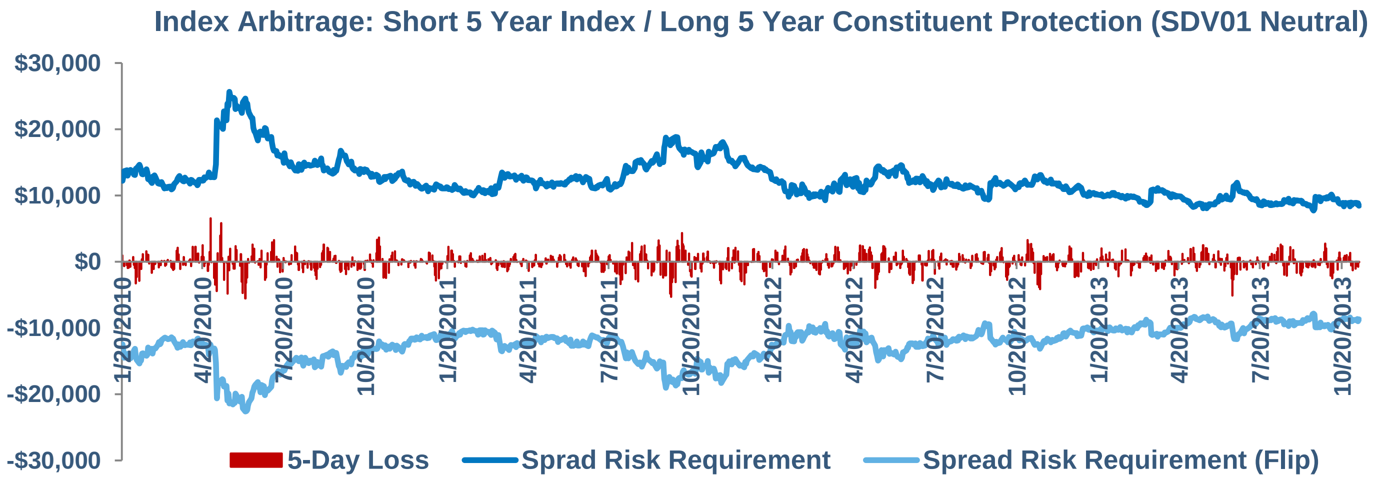




Backtesting Results on 7500 Portfolios : Sample Diversified Portfolios

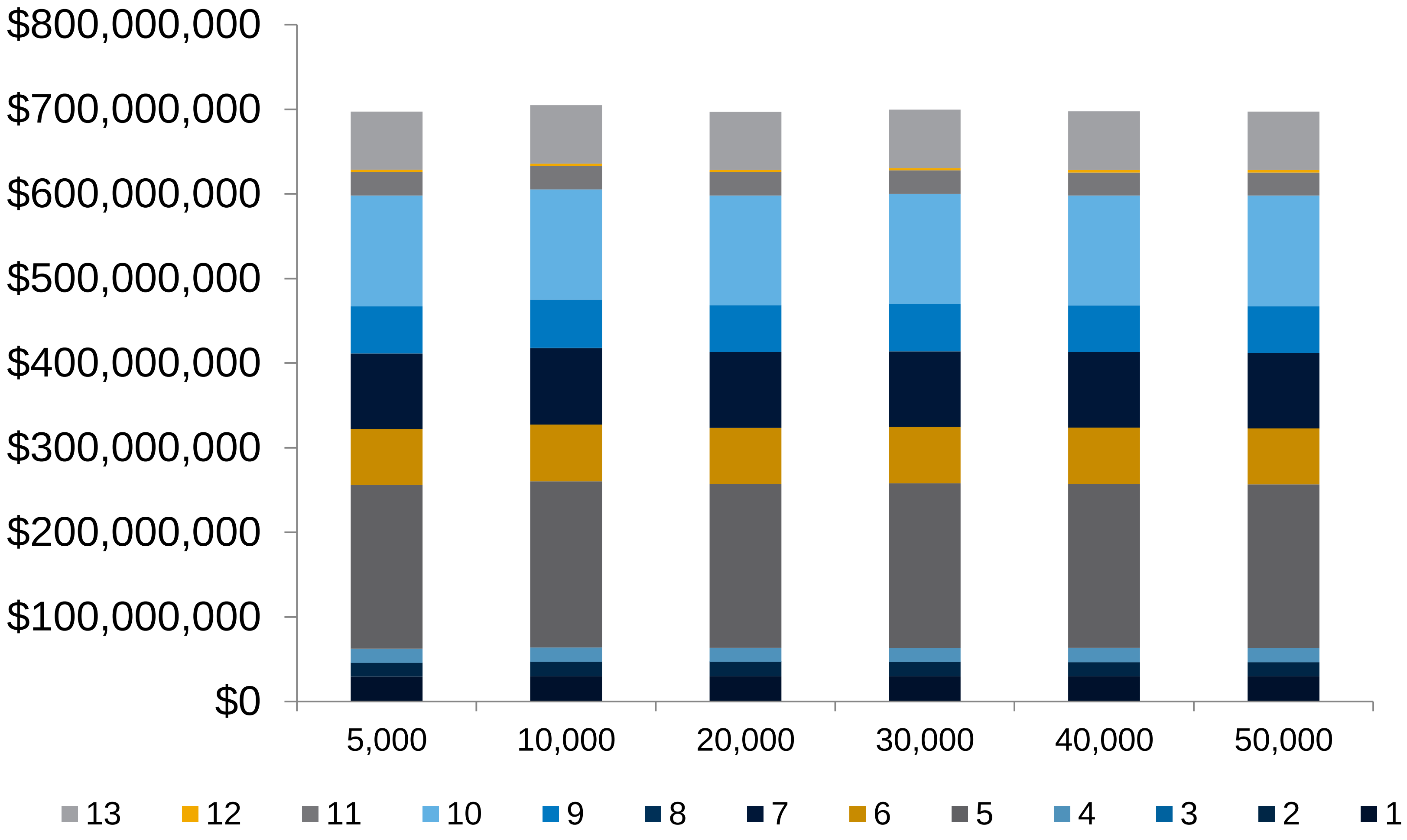


Portfolio	Spread Risk / Gross Notional	Coverage
Original	1.5%	100%
Flip	1.3%	99.90%

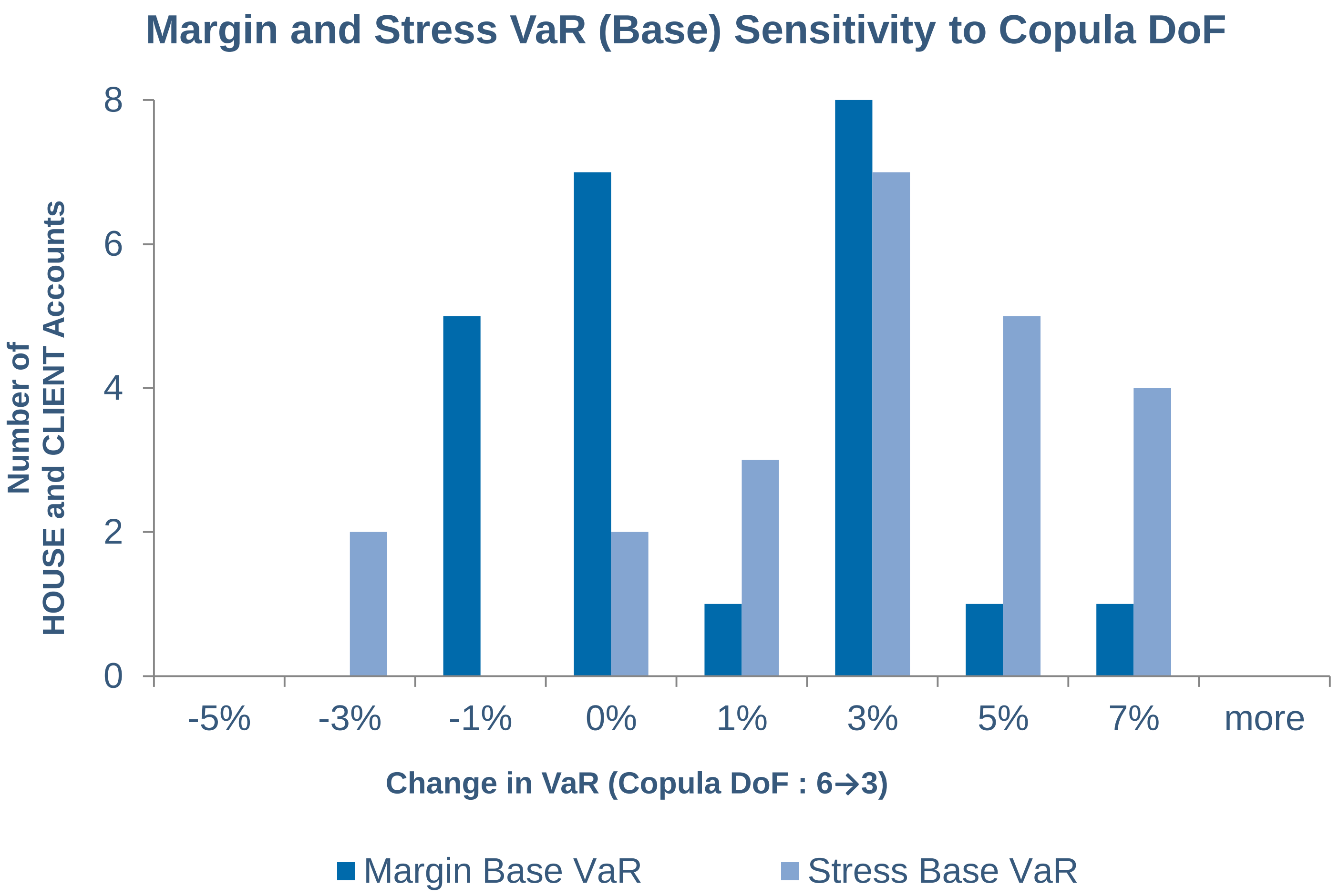


Portfolio	Spread Risk / Gross Notional	Coverage
Original	0.6%	100%
Flip	0.6%	99.90%

Number of Monte Carlo Scenarios : Production Margin Sensitivity Across CMF's



Sensitivity of Margin and Stress of Production Portfolios to Copula Degree of Freedom



Jump to Default and Jump to Health Requirements

FINANC CONCEPTS

Jump To Default/Health: Motivation

- New model for CDS Clearing incorporates statistics of spread movements.
- Co-movements between CDS for different obligors or same obligor and different tenor can be modeled with this approach.
- There are, nevertheless, events which need to be modeled that not fit in the framework of pure statistics for CDS prices/spreads: these are the **corporate events** (CE).
- In the present context, we define corporate events: buy outs, buy ins, defaults, huge drops or increases in credit ratings due to events which are unique in the lifetime of the obligor. These can be called also idyosincratic regime changes.
- CEs can have a dramatic impact on the value of a CDS. The most dramatic one is a default, which triggers the CDS payment. Others CEs are LBOs.
- Others can be Jump To Health, i.e. the radical one-off spread contraction due to the acquisition by a more credit-worthy entity.

Definition of JTH/JTD in the Model

- CE's are rare events for a single company, but they may be frequent in a large multi-obligor portfolio

- We wish to detect vulnerabilities in a portfolio to corporate events. We assume that on the period of interest, only one obligor experiences such CE.

- A JTD event in a portfolio means that one obligor defaults, triggering the CDS protection and the portfolio is short protection in that name

- AT JTH event means that the spreads of a particular obligor contract dramatically to tail risk levels of 99.75%. (This is a parametric assumption, which will need to be validated.

Computation of JTD charge

- Step 1: Tally all the obligors for which the portfolio is short protection. Assume that there are N_s such names. Let $\pi_1, \pi_2, \ldots, \pi_{N_s}$ denote the sub-portfolios that exclude each of the names (complementary portfolios.

- Step 2: For each name for which the portfolio is short protection, compute the **loss given default**:

$$LGD_i = \sum_k n_{ik} \left(P_{ik} - RR_i\right)$$

Here n_{ik} (negative) is the notional amount and P_{ik} is the value of the CDS. The sum is made over tenors.

- Step 3: Compute the **market risk charge** for each complementary portfolio, $\text{e.g.}, MR(\pi_i) = ES_{.99}(\pi_i, 5day\ horizon)$

Computation of JTD Charge

- Step 4. Set

$$JTD = \min_{1 \ll i \ll N_s} \left(MR(\pi_i) + LGD_i - ES_{.99}(\pi) \right)$$

Here π represents the full portfolio.

- Thus the JTD charge is an add on which covers the risk of one defaulting obligor.

Computation of JTH Charge

- Step 4. Define the JTH charge as

$$JTH = \min_{1 \leq i \leq N_l} \left(MR(\pi_i) + LGH_i - ES_{.99}(\pi) \right)$$

Total Charge for JTH/JTD

- If we believe and can justify that one cannot have a default and a jump to health in the same day, then one would just take the worst between the two charges, leading to

JTD-JTH Charge=$\min(JTD, JTH)$

- A more conservative approach would consider each charge as a separate add-on.

- Notice that our approach is quite symmetric: LGD includes the payout of the CDS, LGH includes a compression tail event at level 99.5%

Epilogue:
What is the incoming U.S. Administration's proposal for financial regulation?

HOUSE COMMITTEE ON
FINANCIAL SERVICES

THE FINANCIAL CHOICE ACT

CREATING HOPE AND OPPORTUNITY FOR
INVESTORS, CONSUMERS, AND ENTREPRENEURS

A REPUBLICAN PROPOSAL TO REFORM
THE FINANCIAL REGULATORY SYSTEM

JUNE 23, 2016

From Rep. Jeb Hensarling's office.
Now considered for Secretary of Treasury

The Dodd-Frank Off-Ramp for Strongly Capitalized, Well-Managed Banking Organizations

Executive Summary:

- **Excessive regulatory complexity – embodied by the Dodd-Frank Act, the Basel capital accords, and other post-crisis regulatory initiatives – produces a less resilient financial system, cements the competitive advantages enjoyed by "too big to fail" firms, and harms economic growth.**

- **Dodd-Frank's particular brand of regulatory complexity and government micro-management has made basic financial services less accessible to small businesses and lower-income Americans, by saddling America's small and medium-sized community financial institutions with a crushing regulatory burden.**

- **The Financial CHOICE Act enhances U.S. financial market resiliency and promotes economic growth by offering well-managed, well-capitalized financial institutions – those with a simple leverage ratio of 10 percent – an "off ramp" from Dodd-Frank's suffocating regulatory complexity.**

Bankruptcy Not Bailouts

Executive Summary:

- **Dodd-Frank has *not* ended "too big to fail": research by the Richmond Federal Reserve Bank shows that 60 percent of total financial system liabilities (or some $26 trillion) are either explicitly or implicitly federally guaranteed – a figure essentially unchanged since the passage of Dodd-Frank.**

- **Taxpayers remain on the hook for Wall Street risk-taking thanks to Dodd-Frank's Orderly Liquidation Authority, its failure to impose meaningful constraints on the Federal Reserve's emergency lending authority, its misguided regime for designating large financial firms as "too big to fail," and assorted other provisions backstopping the financial system.**

- **The Financial CHOICE Act ends bailouts and establishes a new chapter in bankruptcy code that preserves the rule of law while enabling large, complex financial institutions to fail safely without making taxpayers foot the bill.**

Repeal of the Financial Stability Oversight Council's SIFI Designation Authority

<u>Executive Summary:</u>

- The Financial Stability Oversight Council's highly politicized structure and penchant for secrecy are emblematic of a "shadow regulatory system" that is both antithetical to democratic principles and harmful to the U.S. economy.

- The FSOC injects unprecedented levels of political risk into the financial system by equipping a council composed largely of Presidential appointees with the authority to dictate the range of acceptable activities and the size and scope of private financial firms.

- The FSOC's process for designating non-bank financial institutions and so-called "financial market utilities" as "systemically important," based upon vague and ill-defined standards, gives regulators broad license to concentrate more power in Washington.

- By repealing the FSOC's designation authority, the Financial CHOICE Act addresses one of Dodd-Frank's greatest sources of regulatory overreach, and eliminates the government's authority to anoint large financial institutions as "too big to fail."

Reform the Consumer Financial Protection Bureau

<u>Executive Summary:</u>

- The Consumer Financial Protection Bureau is not accountable to Congress or the American people. The Bureau's policies often harm consumers or exceed its legal authority because the Bureau is not subject to checks and balances that apply to other regulatory agencies.

- The Bureau symbolizes a paternalistic approach to consumer protection that empowers bureaucrats while denying consumers access to financial products and services they want and need.

- The Financial CHOICE Act will increase accountability by changing the Bureau's governance and funding mechanism, and promote real consumer protection by putting power where it belongs: in the hands of consumers, not Washington bureaucrats.

Relief from Regulatory Burden for Community Financial Institutions

Executive Summary:

- Dodd-Frank may have been intended to rein in large, complex financial institutions, but it disproportionately burdens community financial institutions.

- Left unaddressed, the hundreds of new rules stemming from Dodd-Frank will only result in more rapid industry consolidation. The big banks will grow larger, while the smaller banks will become fewer.

- Increasing regulatory costs are inevitably passed on to customers in the form of higher prices and diminished credit availability.

- Addressing the weaknesses of the Dodd-Frank Act will increase consumer and small business access to credit by allowing community financial institutions to cease hiring compliance officers and resume hiring loan officers.

Federal Reserve Reform

<u>Executive Summary:</u>

- **Dodd-Frank rewarded the governmental entity arguably most responsible for the financial crisis – the Federal Reserve – with expansive new regulatory powers, lending credence to the adage that at least in Washington, nothing succeeds like failure.**

- **By amassing a $4.5 trillion balance sheet and engaging in credit allocation on a grand scale, the Fed has blurred the line between fiscal and monetary policy beyond recognition, and in doing so has undermined its political independence.**

- **For far too long, the Federal Reserve has sought to shield its prudential regulatory actions behind the cloak of its monetary policy independence. The Financial CHOICE Act scales back the Fed's regulatory and supervisory powers and subjects them to greater congressional oversight and accountability.**

- **By promoting a more predictable, rules-based monetary policy, the Financial CHOICE Act provides a stronger foundation for economic growth than the Fed's improvisational approach of recent years, the results of which have been underwhelming to say the least. Although Fed Chair Yellen has opposed these modest reforms, they are supported by a long list of leading economists, including three recent Nobel Laureates.**

Upholding Article I: Reining in the Administrative State

Executive Summary:

- **The Constitution envisioned a system of checks and balances whereby power would be distributed among three distinct branches of government. Financial regulators instead exercise the powers of all three branches of government, aided by Dodd-Frank provisions that have largely immunized them from accountability to Congress, the President, and the courts.**

- **The Dodd-Frank Act erodes rule of law principles and produces unnecessarily costly regulations – which harm job creation and limit economic opportunity – by devolving enormous power to unaccountable and unelected agency bureaucrats.**

- **Only by restoring the Constitutional separation of powers and reclaiming its legislative authority can Congress restore accountability and democratic control over federal agencies and ensure the financial regulatory process is accountable, fair, and efficient.**

- **Failure to conduct cost-benefit analysis reduces the quality of regulation and creates unnecessary regulatory costs; it does a disservice to the American people. By imposing a statutory cost-benefit analysis requirement on financial regulators, the Financial CHOICE Act will yield benefits to consumers, investors, and the broader economy.**

Amend Dodd-Frank Title IV

Executive Summary

- Although private equity funds did not cause nor contribute to the financial crisis, Dodd-Frank imposes burdensome requirements on advisers to private equity funds, which unnecessarily punishes their investors and impedes job creation.

- Title IV of the Dodd-Frank Act requires the SEC to expend scarce resources on the protection of sophisticated institutional investors and wealthy individual investors that would be better utilized protecting the millions of retail investors of more modest means who have a far greater need for the SEC's assistance.

- The Financial CHOICE Act amends Title IV of the Dodd-Frank Act to enhance funding opportunities for start-up companies and other job creators and to focus government resources on protecting mom-and-pop investors instead of the wealthiest Americans.

Repeal the Volcker Rule

Executive Summary:

- **From its inception, the Volcker Rule has been a solution in search of a problem – it seeks to address activities that had nothing to do with the financial crisis, and its practical effect has been to undermine financial stability rather than preserve it.**

- **The Volcker Rule will increase borrowing costs for businesses, lower investment returns for households, and reduce economic activity overall because it constrains market-making activity that has already reduced liquidity in key fixed-income markets, including the corporate bond market.**

- **Repeal of the Volcker Rule will promote more resilient capital markets and a more stable financial system.**

Repeal the Durbin Amendment

Executive Summary:

- **The Durbin Amendment, which was inserted into the Dodd-Frank Act without adequate congressional deliberation, is a price-fixing scheme that picks winners and losers in the marketplace.**

- **The Durbin Amendment has resulted in the elimination of free checking accounts at banks, pushing vulnerable Americans out of the mainstream banking system, while providing no discernible benefit to retail consumers.**

Eliminate the Office of Financial Research

Executive Summary:

- By driving regulators towards a homogenized view of financial system threats, the OFR contributes to a "one-world view" of risk that has had such disastrous consequences in Basel and other regulatory contexts. Eliminating the OFR would actually *improve* risk management by encouraging diverse perceptions of risk and risk management strategies.

- There are countless other federal agencies – most notably the Federal Reserve, which maintains a "Division of Financial Stability" and employs over 300 PhD economists – that perform market surveillance and collect and analyze data for purposes of identifying threats to financial stability. Eliminating the OFR will result in one less redundant federal bureaucracy.

Sorry, JPF!

SEC Enforcement Issues

Executive Summary:

- Because both Wall Street and Washington must be held accountable if future financial melt-downs are to be averted, the Financial CHOICE Act increases penalties for violations of the securities laws for individuals and entities, but couples those increases with important reforms to the SEC's enforcement program designed to promote the rule of law and ensure due process.

- The vigorous enforcement of the federal securities laws is paramount and the SEC must have the tools it needs to deter and punish wrongdoing and, whenever possible, to make defrauded investors whole. But the SEC must strike the right balance between deterring and punishing securities fraud and protecting shareholders from paying unnecessarily for the sins of rogue corporate officers and employees, who have rarely been the subject of disciplinary action or financial penalties in post-crisis enforcement actions. By requiring the SEC to incorporate economic analysis in its deliberations on enforcement matters, the Financial CHOICE Act will help ensure that shareholder interests are recognized and protected to a greater extent than is currently the case.

- All individuals who are either under investigation by the SEC or appear before the SEC in administrative proceedings must have a full and complete opportunity to defend themselves. The Financial CHOICE Act's provisions affording defendants in SEC administrative proceedings a right of removal to federal court will help ensure that those defendants receive due process, and eliminate the unfair "home court advantage" that the SEC has sought to gain by steering cases to its in-house administrative law judges.

Capital Formation

Executive Summary:

- Small companies are at the forefront of technological innovation and job creation, they face significant obstacles in obtaining funding in the capital markets. These obstacles are often attributable to the proportionately larger burden that securities regulations—written for large public companies—place on small companies when they seek to go public.

- Over the last 35 years, the SEC has established several offices and committees to promote small business capital formation, but it has largely failed to adopt any of the recommendations made by these panels. At a time when the American people continue to struggle with the slowest, weakest recovery of the post-war era, the SEC's inattention to these issues is unacceptable. If the SEC will not make capital formation a priority, it is incumbent upon Congress to do it for them.

- The best way to protect investors is to foster competitive markets that encourage innovation, expand the investment opportunities available to all investors, and promote a regulatory regime that acknowledges the differences between small, private and start-up companies and well-established public companies. The Financial CHOICE Act contains a host of provisions designed to advance these objectives.

Reforms to Title IX of Dodd-Frank

Executive Summary:

- Title IX of the Dodd-Frank Act is an almost perfect embodiment of the adage coined by former Obama chief of staff Rahm Emanuel in the early days of the Administration: "Never let a good crisis go to waste." It consists of a grab bag of items culled from the wish list of congressional Democrats and their political allies that in most instances have nothing to do with addressing the causes of the financial crisis.

- The Dodd-Frank Act represented a missed opportunity to streamline and rationalize the SEC's balkanized and overly bureaucratic structure. The Financial CHOICE Act includes organizational changes and other reforms of the SEC that will make for a more nimble, less sclerotic agency better-suited to fulfilling its statutory mission.

- Imposing a fiduciary duty on broker-dealers will raise costs and reduce access to investment advice for retail investors, costing Americans billions of dollars in lost retirement savings.

Repeal Specialized Public Company Disclosures for Conflict Minerals, Extractive Industries, and Mine Safety

Executive Summary:

- Title XV of the Dodd-Frank Act imposes a number of overly burdensome disclosure requirements related to conflict minerals, extractive industries, and mine safety that bear no rational relationship to the SEC's statutory mission to protect investors, maintain fair, orderly, and efficient markets, and promote capital formation. The Financial CHOICE Act repeals those requirements.

- There is overwhelming evidence that Dodd-Frank's conflict minerals disclosure requirement has done far more harm than good to its intended beneficiaries – the citizens of the Democratic Republic of Congo and neighboring Central African countries.

- SEC Chair Mary Jo White, an Obama appointee, has conceded the Commission is not the appropriate agency to carry out humanitarian policy. The provisions of Title XV of the Dodd-Frank Act are a prime example of the increasing use of the federal securities laws as a cudgel to force public companies to disclose extraneous political, social, and environmental matters in their periodic filings.

Improving Insurance Regulation by Reforming Dodd-Frank Title V

Executive Summary:

- The Dodd-Frank Act created new, overlapping and conflicting federal insurance positions between the FIO Director and the FSOC Independent Member with Insurance Expertise that have produced fragmentation, not consolidation within our financial system.

- Consolidating federal insurance positions into one advocate will give a unified voice and seat at the table for the U.S. insurance industry at the domestic and international levels, while preserving our traditional state-based system of insurance regulation.