

Certificate of Quantitative Finance

Collateral and Margins

Jon Gregory, 6th August 2020

In This Lecture

i) Derivatives as Financial Weapons of Mass Destruction

ii) Risk Mitigation in Derivatives

iii) Collateral in OTC Derivatives

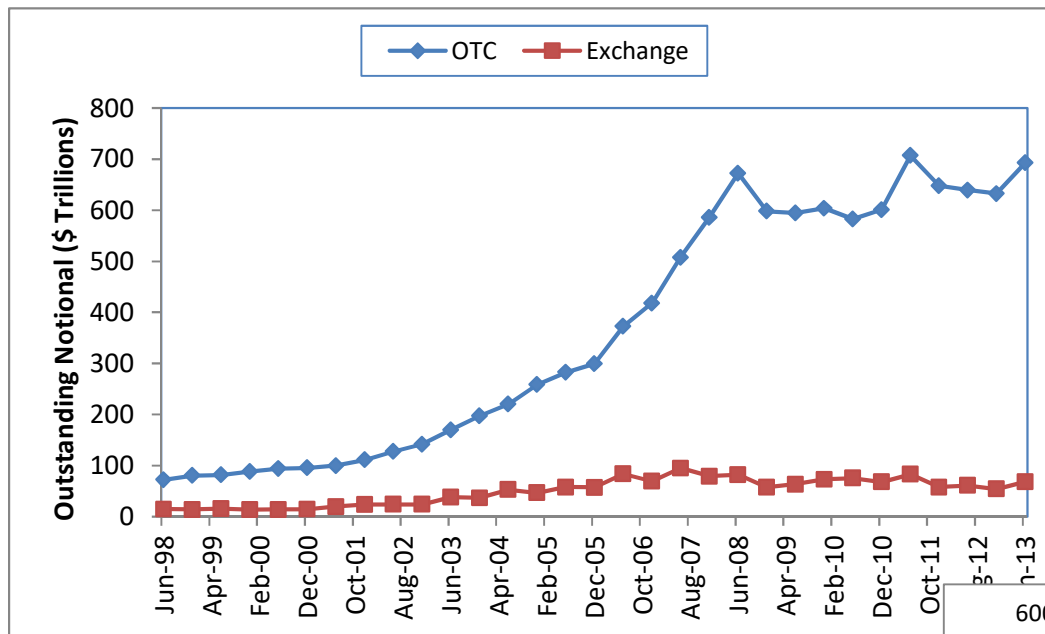
iv) Central Clearing

v) Bilateral Margin Requirements

vi) Initial Margin Methodologies

vii) The Dangers of Clearing and Overcollateralisation

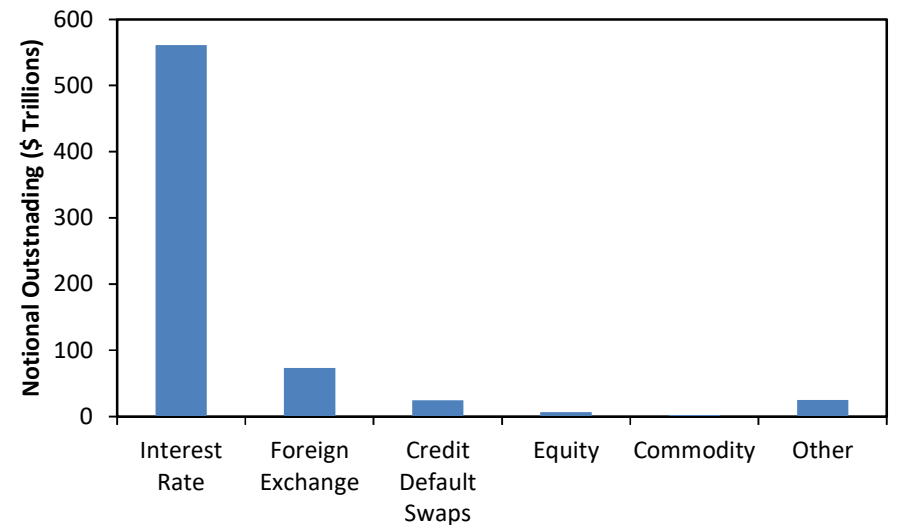
The Growth of the OTC derivatives market



- OTC derivatives dominate exchange-traded although comparison is not trivial

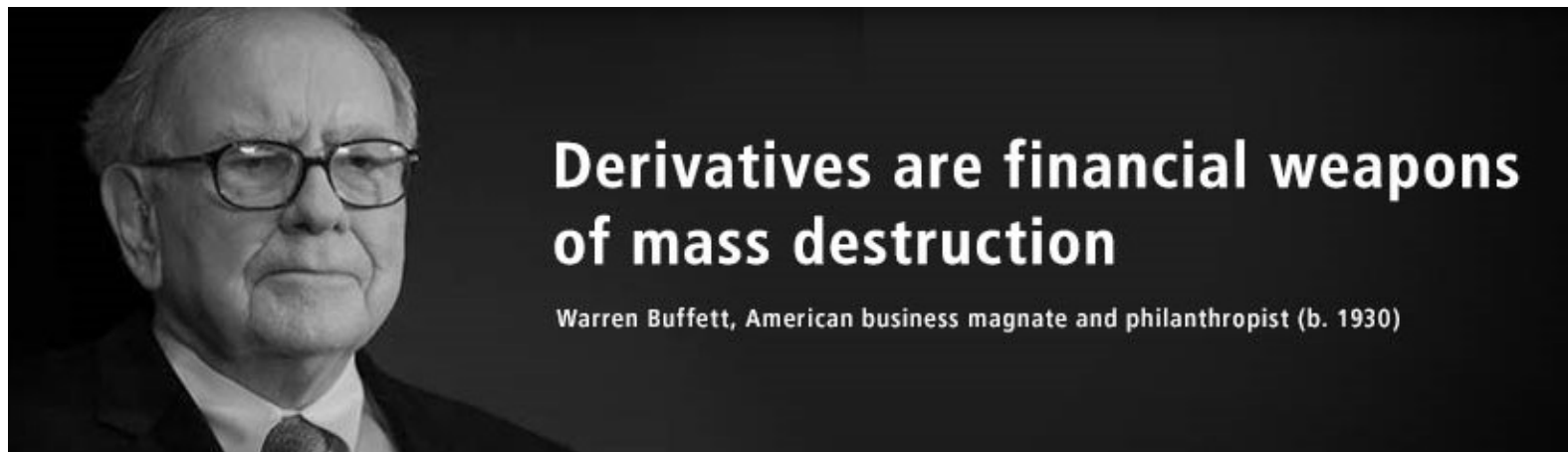
Source: BIS

- Exchange-traded contracts have more netting benefit
- OTC derivatives are generally longer-dated (\$1m in notional of a 10 year IRS is equivalent to \$40m in notional in Eurodollar futures)

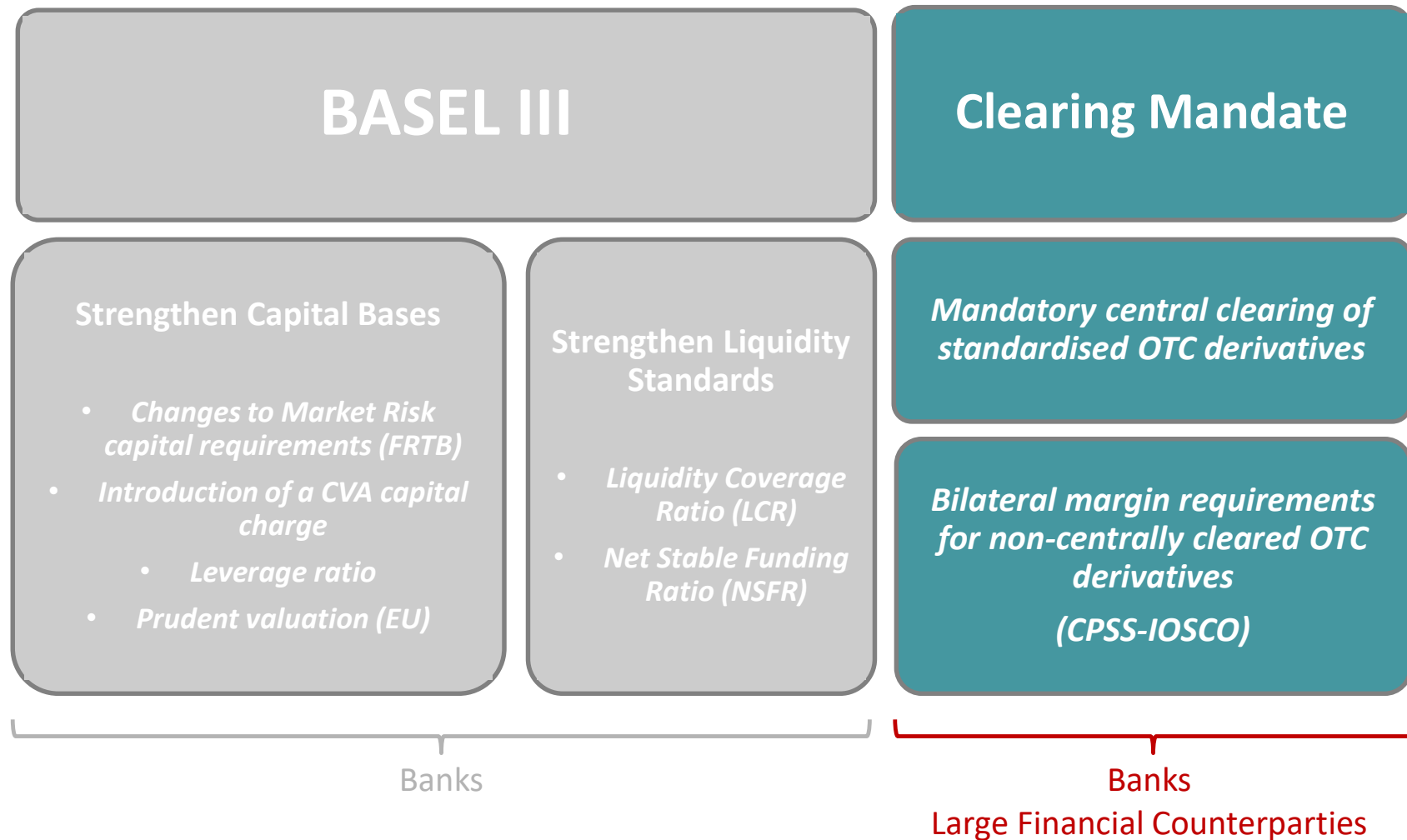


First Thoughts

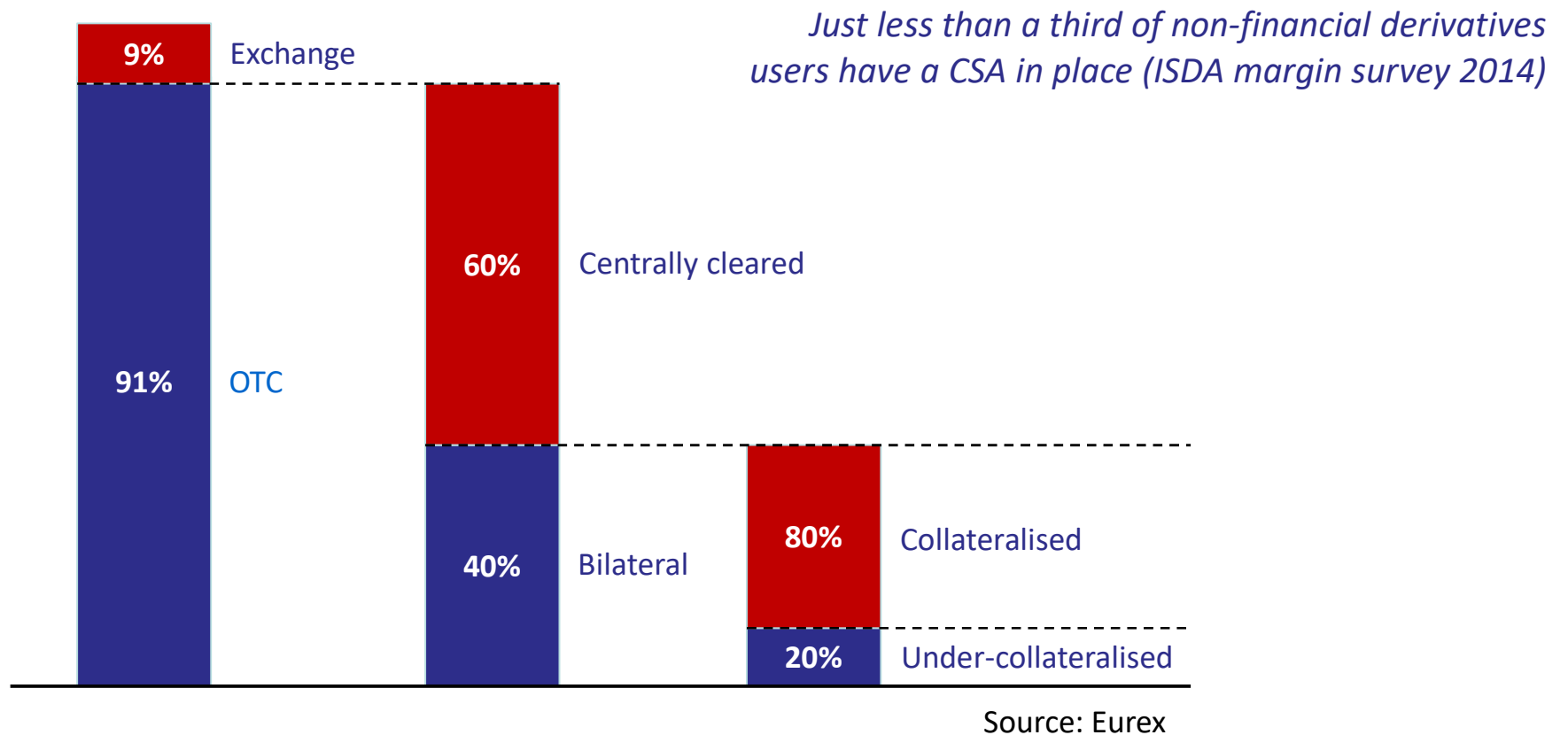
- In Berkshire Hathaway's 2002 annual report, Warren Buffet warns of derivatives:
 - Without collateralization their value depends on the creditworthiness of the counterpart
 - Their mark-to-market can be mark-to-myth and there are no incentives to assure otherwise
 - They often have downgrade triggers requiring greater collateralization, just at the worst time
 - They create a daisy-chain risk, thwarting prudent counterparty diversification



Regulation



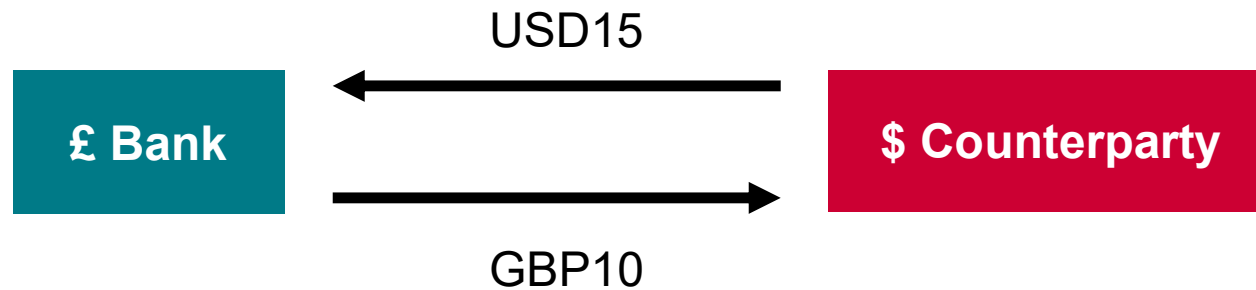
The Derivative Market and Collateralisation



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Settlement Risk



■ Options

- Cash settlement (e.g. non-deliverable forwards)
- Safe settlement (CLS bank)

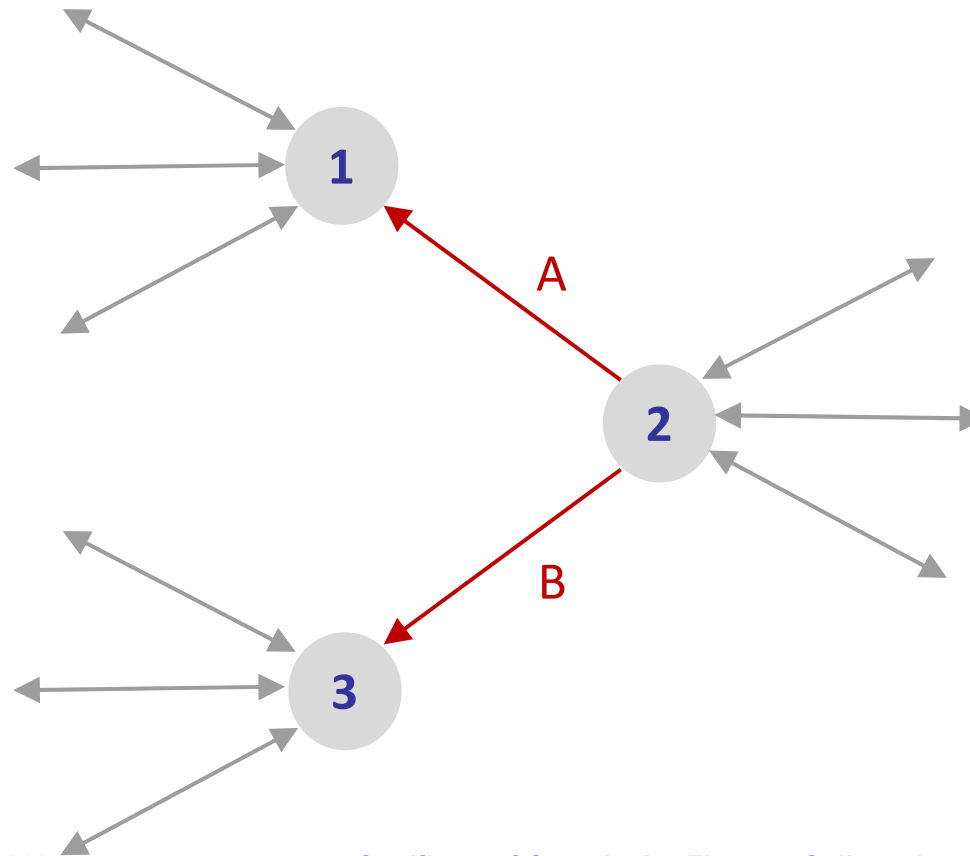
Close-out Netting

	Bank A	Bank B
Derivative trade 1	+100	
Derivative trade 2		+50
Derivative trade 3	+200	
Derivative trade 4		+300
Derivative trade 5	+150	
Gross exposures	+450	+350

Net uncollateralised exposure	+100
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Portfolio Compression

- Suppose A and B are perfectly offsetting transactions
 - May be able to cancel them depending on the rest of the network
 - Multilateral netting



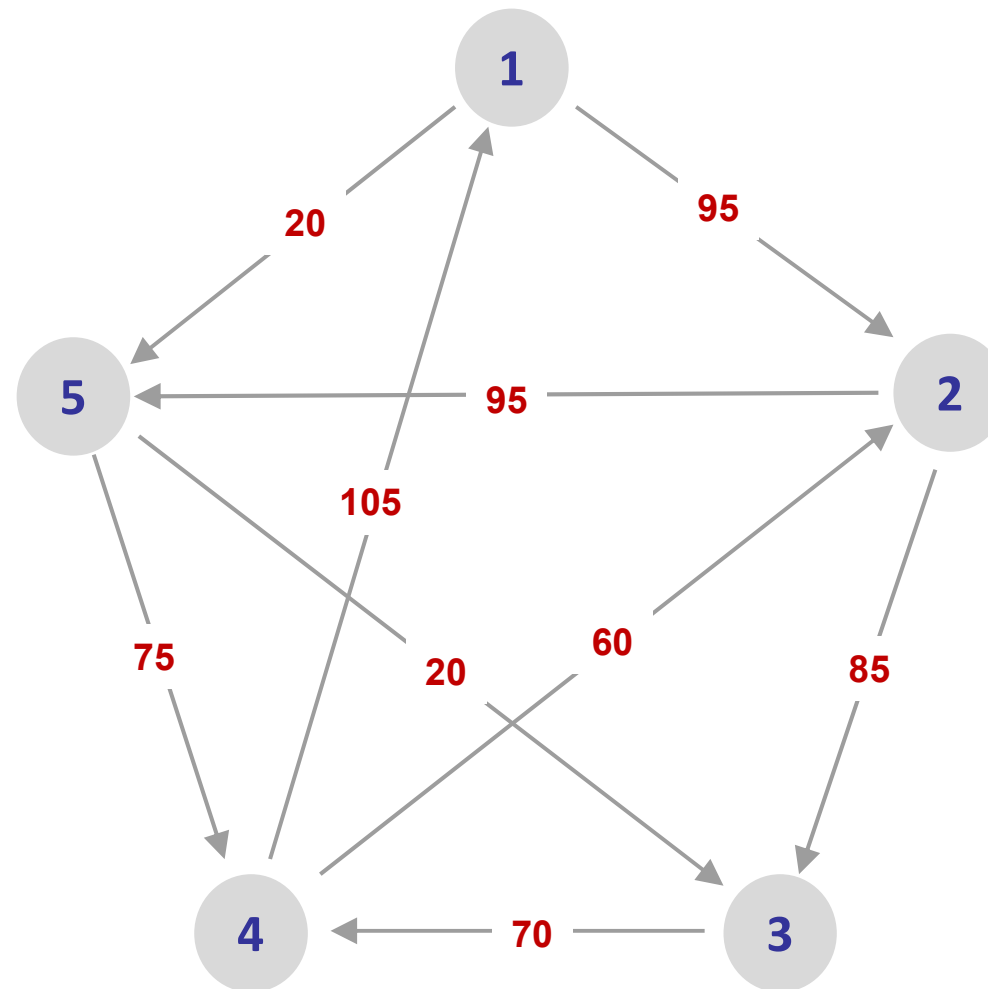
Compression Example – Initial Fungible Positions

	Cntrpty 1	Cntrpty 2	Cntrpty 3	Cntrpty 4	Cntrpty 5	Total
Cntrpty 1	-	95	0	-105	20	10
Cntrpty 2	-95	-	85	-60	95	25
Cntrpty 3	0	-85	-	70	-20	-35
Cntrpty 4	105	60	-70	-	-75	20
Cntrpty 5	-20	-95	20	75	-	-20

Must be held fixed

Total notional = 1250

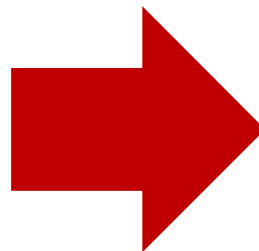
Compression Example – Initial Network



Trade Compression: CDS Example

Instrument details	
Underlying	Nestle SA
Fixed coupon	100 bps
Maturity	20 September 2022
Dealer Bank's position	100 (net long), 400 (gross longs)

Counterparty	Long/(Short)
A	100
B	(50)
C	150
D	(100)
E	50
F	(150)
G	100



Counterparty	Long/(Short)
Any of A, C, G or combination including E	100

Cashflow Compression: Blended Rate Compression IRS Example

Trade	Pay/ Rec	Notional (\$)	Fixed rate	Annualised cash flow (\$)
1	Rec	100,000,000	2.34%	2,340,000
2	Rec	75,000,000	2.36%	1,770,000
3	Rec	50,000,000	2.38%	1,190,000
4	Pay	-150,000,000	2.35%	- 3,525,000
5	Rec	100,000,000	2.28%	2,280,000
6	Pay	-125,000,000	2.30%	- 2,875,000
Total (Net)		50,000,000		1,180,000
Total (Gross)		600,000,000		

Risk replacement trade				
Trade	Pay/ Rec	Notional (\$)	Fixed rate	Annualised cash flow (\$)
	Rec	50,000,000	2.36%	1,180,000

Bilateral OTC Markets - Overview

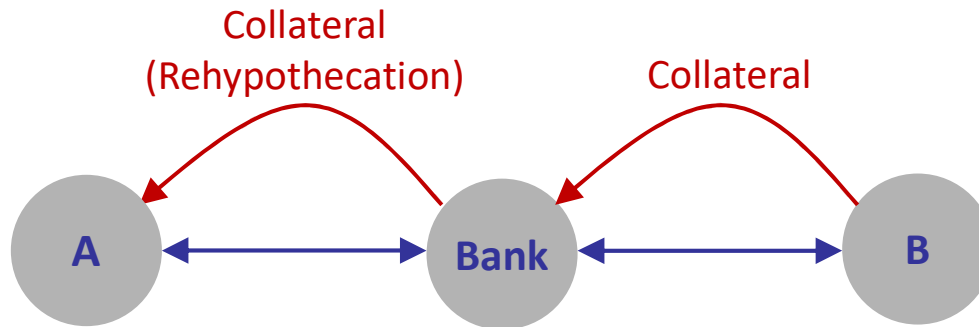


- **Netting**
 - Bilateral (potentially multilateral compression)
- **Collateral**
 - Bespoke agreement between counterparties (ISDA CSA)
- **Default**
 - Can declare a counterparty in default if they fail to post collateral after cure period
- **Close-out**
 - Surviving counterparty makes determination according to documentation
 - Potential for litigation (many examples in the case of Lehman)
- **Replacement**
 - Bilateral

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Collateral (margin)

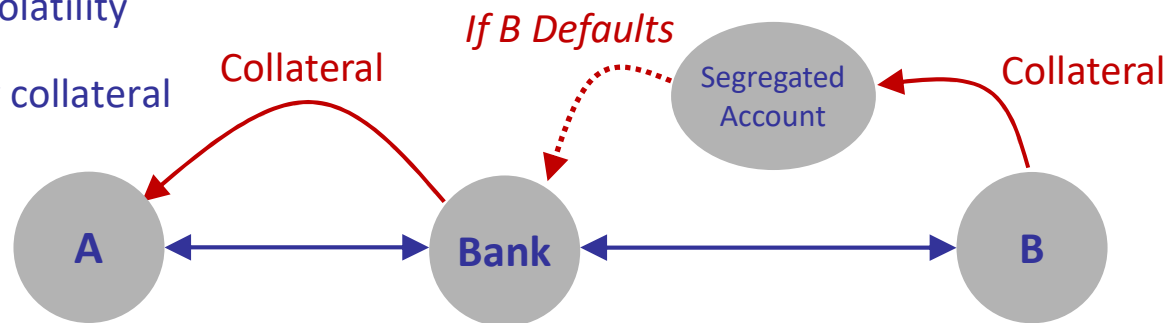


■ Potential problems

- Thresholds
- Margin period of risk
- Rehypothecation of collateral
- Collateral volatility
- Wrong way collateral

In general, FVA reflects a market funding risk premium inherent in the uncollateralized portion of derivative portfolios, and in collateralized derivatives where the terms of the agreement do not permit the reuse of the collateral received.

Spot the difference



Collateral

	Bank A	Bank B
Derivative trade 1	+100	
Derivative trade 2		+50
Derivative trade 3	+200	
Derivative trade 4		+300
Derivative trade 5	+150	
Gross exposures	+450	+350

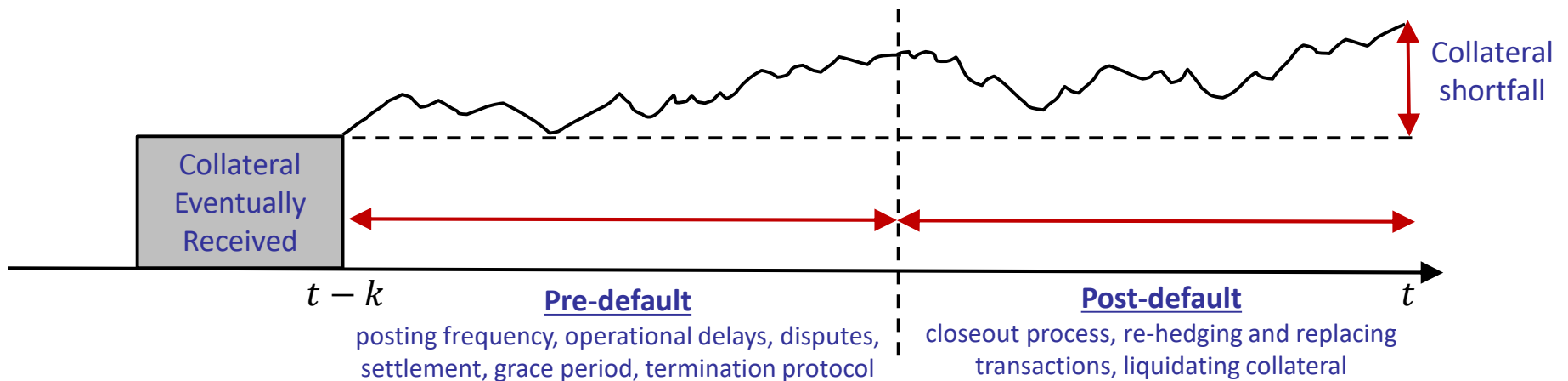
Net uncollateralised exposure	+100
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Credit support amount	(90)
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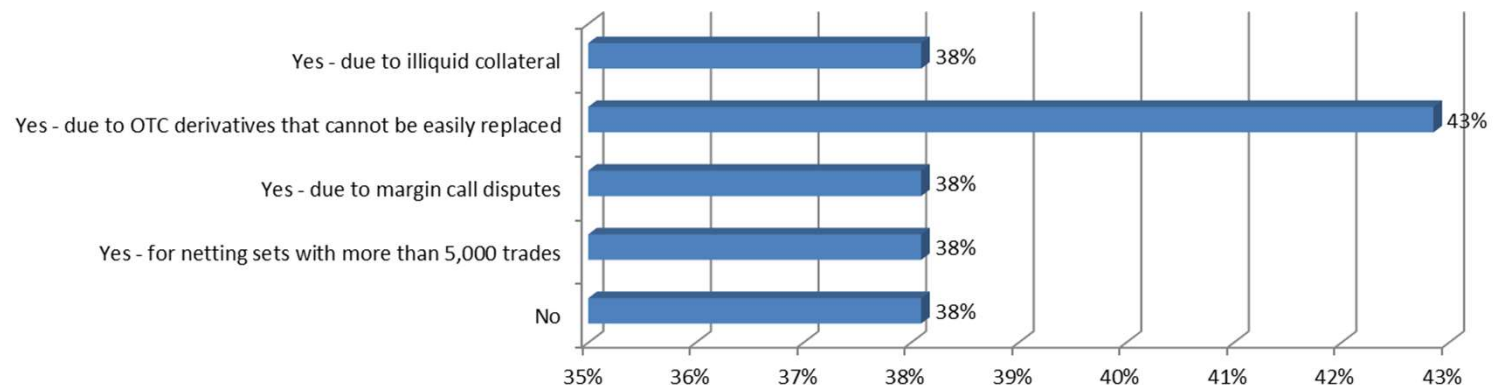
Net exposure	+10
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Margin Period of Risk (MPR)

- Margin period of risk is a delay assuming that collateral will always arrive late

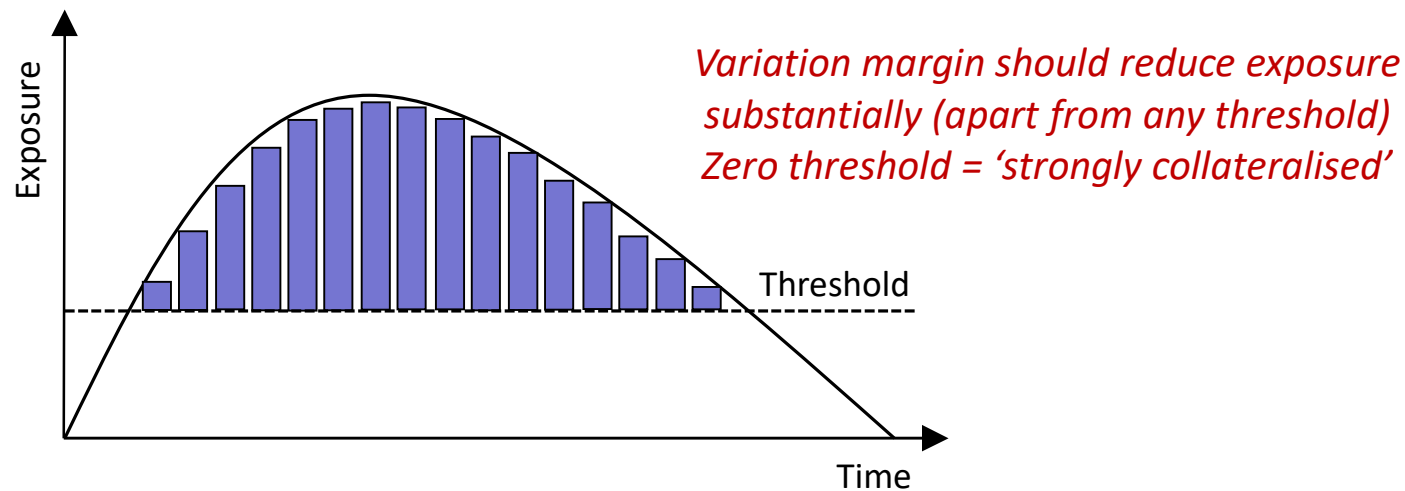


Have you had to apply increased margin period of risk assumptions under Basel III? (*)

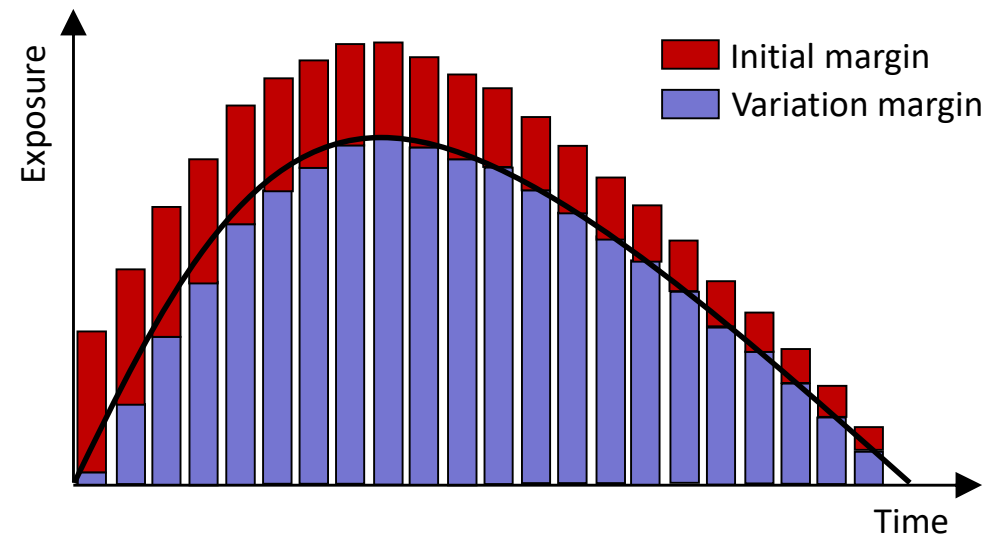


Minimum MPR is 10 business days for OTC derivatives (Basel III in some cases requires 20 days or more)

Collateral Reducing Exposure



Initial margin should reduce exposure even further potentially so that it is negligible ('overcollateralisation')



Lehman, Citi Settle \$2 Billion Financial Crisis-Era Dispute

■ Key Points*

- Citigroup said it was owed \$2 billion as a result of Lehman's bankruptcy
- Lehman against this and claimed that the money in fact should go to its creditors
- Lehman accused Citigroup using methods such as “phantom transaction costs” to try and justify its claim
- Citigroup agreed to give back \$1.74 billion to the estate of Lehman from a total of \$2.1 billion

“Citigroup says it used its best professional judgment to determine close-out amounts on the trades. The contracts, the bank said, were governed by ISDA agreements which give the non-defaulting party -- in this case Citigroup -- the right to assess the close-out costs as long as it uses commercially reasonable procedures.”

* Source: Bloomberg 30th September 2017

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OTC Derivatives and the Crisis

- **OTC derivatives were generally seen as causing / contributing to the global financial crisis (2007 onwards)**

- Lehman had millions of OTC trades which were difficult to closeout and replace
- Fear of knock-on effects and other systemic concerns
- Lack of transparency

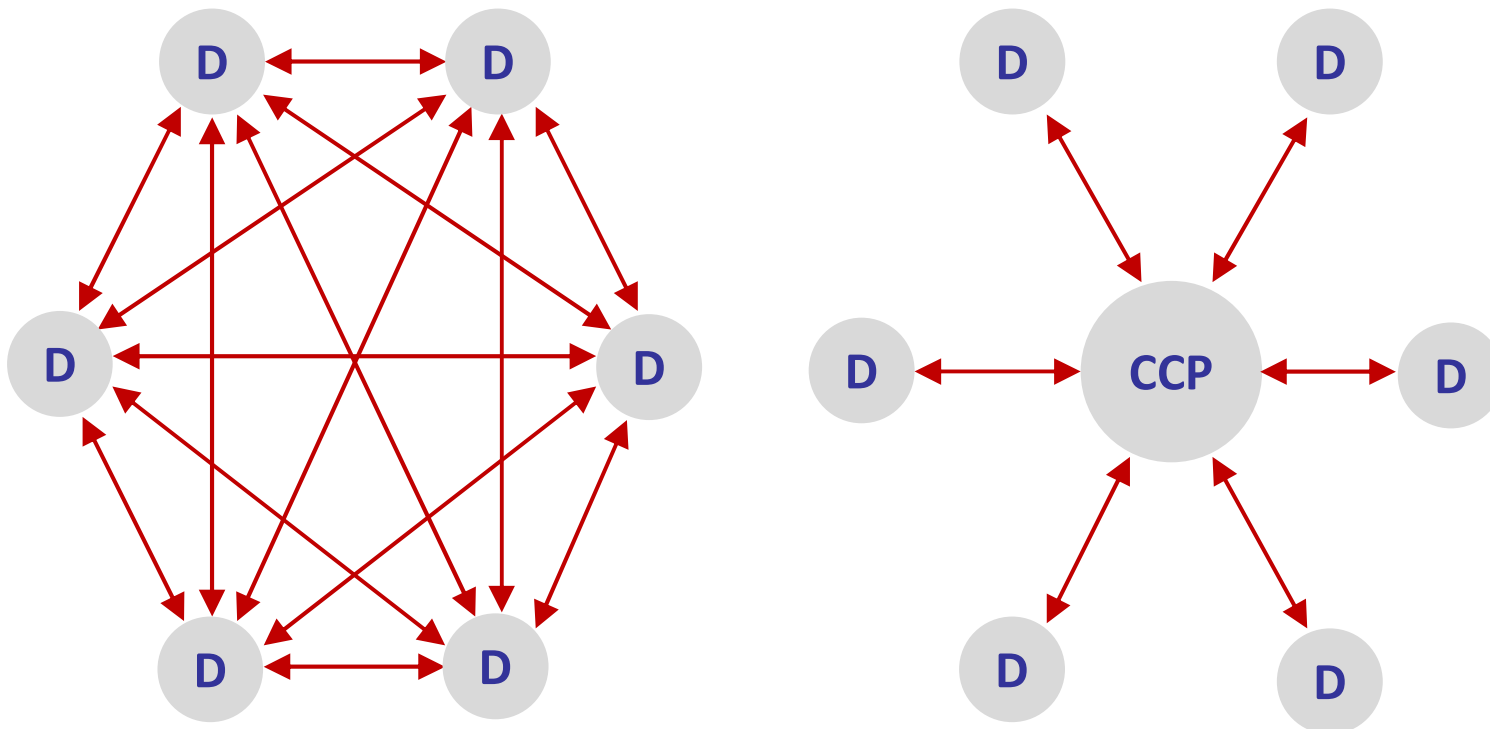
“The primary advantage of a CCP is its ability to reduce systemic risk through multilateral netting of exposures, the enforcement of robust risk management standards, and mutualization of losses resulting from clearing member failures.”

- **What about CCPs?**

International Monetary Fund, 2010, “Making over-the-counter derivatives safer: the role of central counterparties”, Chapter 3, Global Financial Stability Report April

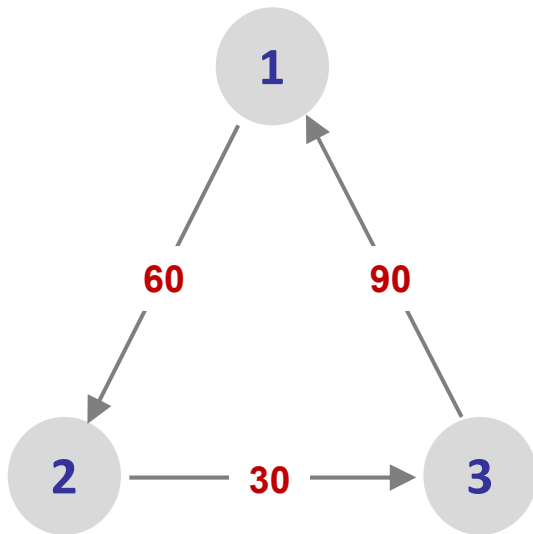
- SwapClear had a \$9 trillion 66,000 trade interest rate portfolio to deal with
- Closed out all positions within 3 weeks (most of the risk was hedged prior to this)
- Held enough initial margin from Lehman to cover related losses (they returned two thirds)

Centrally Cleared Market - Dealers

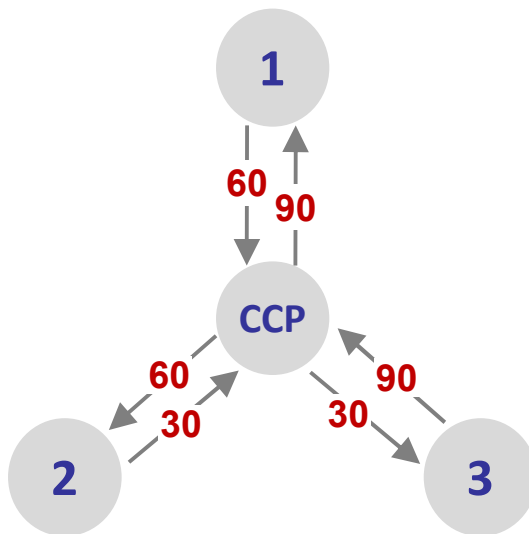


Netting

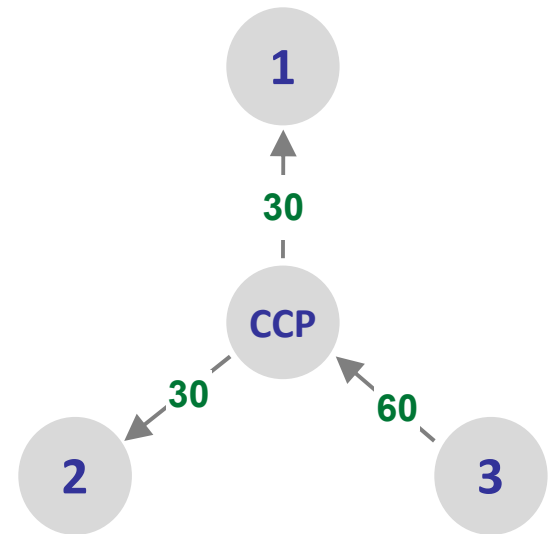
Bilateral market



Novation to CCP

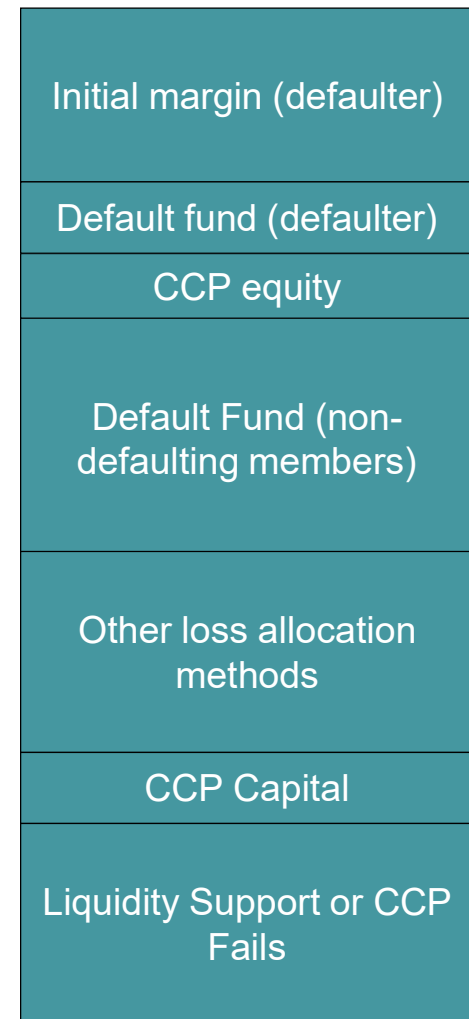
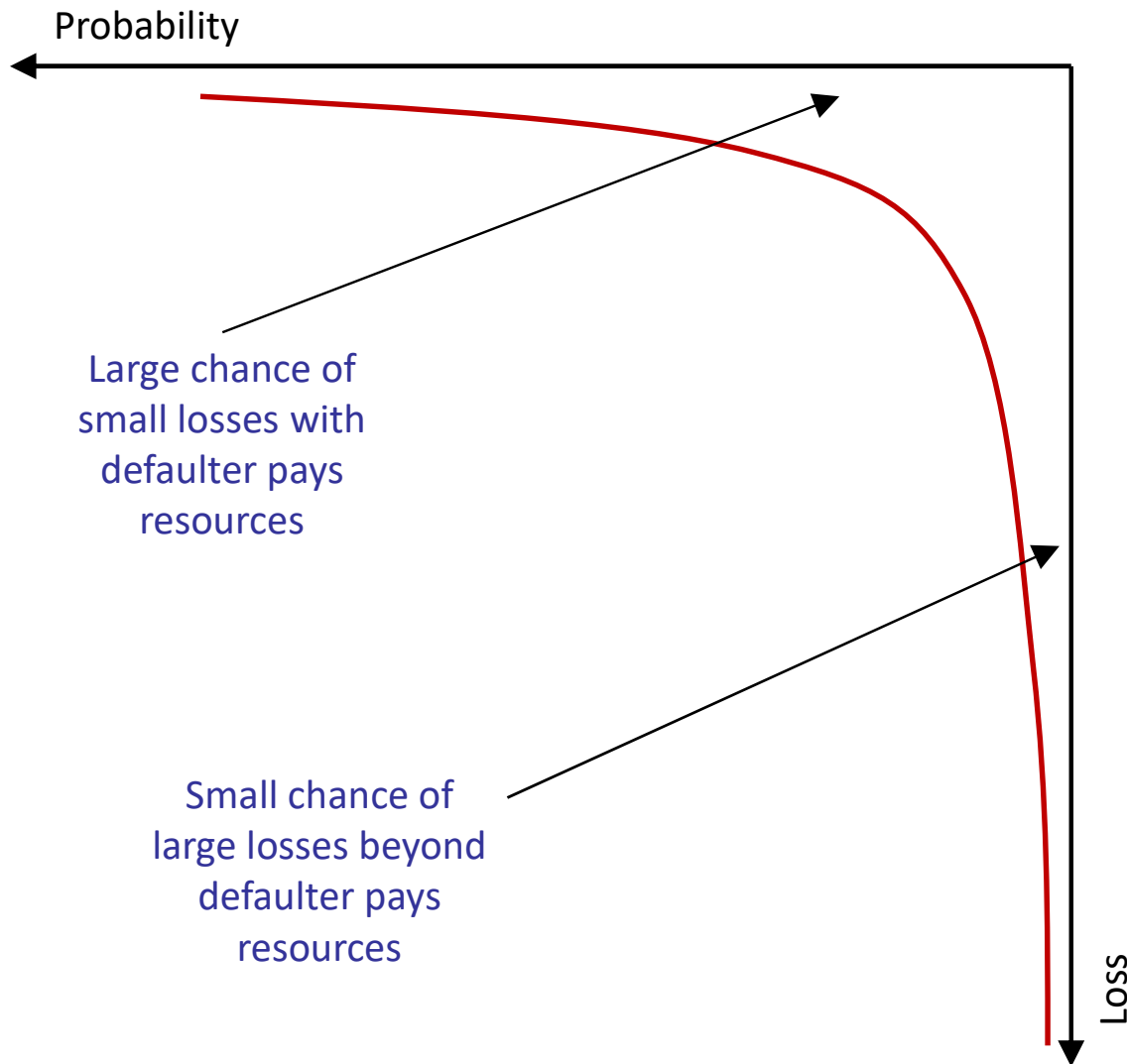


CCP Netting



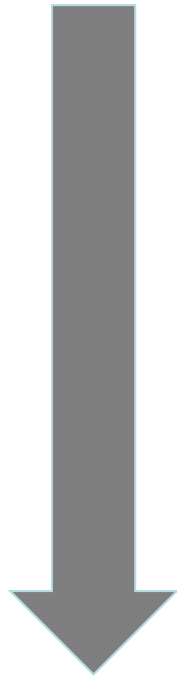
	Exposure	
	Bilateral	Centrally cleared
Cntrpty 1	90	30
Cntrpty 2	60	30
Cntrpty 3	30	0
CCP	n/a	60

The Loss Waterfall and Loss Distribution



Default Fund – LCH and Lehman Brothers (2008)

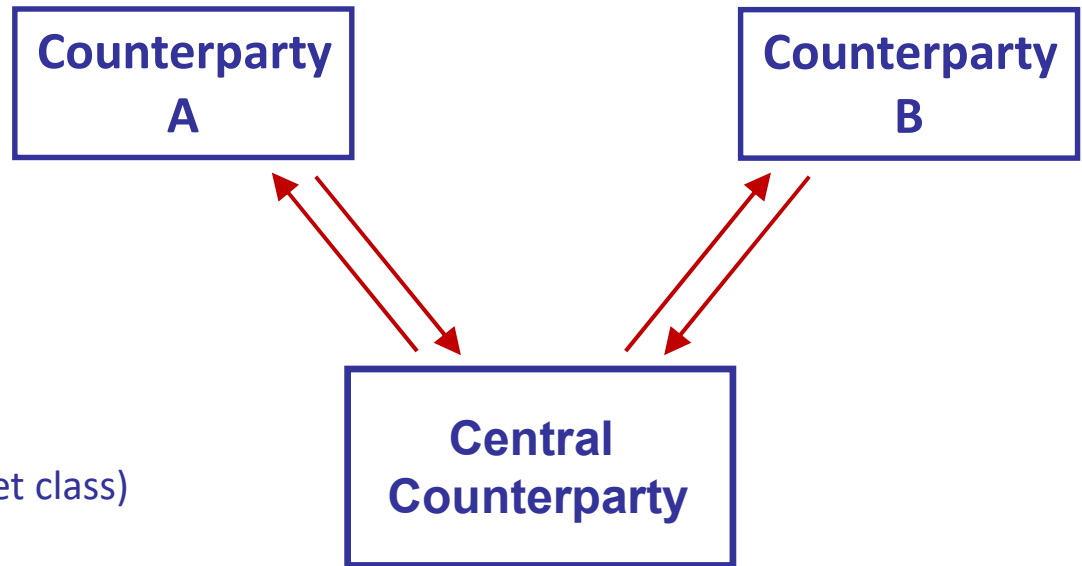
Losses



Initial margin (defaulter)
Default fund (defaulter)
CCP equity
Default Fund (non-defaulting members)
Other loss allocation methods
CCP Capital
Liquidity Support or CCP Fails

Approx one third of IM

Cleared Markets - Overview



- **Netting**
 - Multilateral (broadly within asset class)
- **Collateral**
 - Gold-standard CCP agreement involving variation and initial margin
- **Default**
 - Can declare a counterparty in default if they fail to pay margin or there is a solvency concern
- **Close-out**
 - CCP macro hedging and auction
- **Replacement**
 - Central

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Bilateral Margin Requirements - Motivation

Margin requirements for non-centrally cleared derivatives have two main benefits:

Reduction of systemic risk. Only standardised derivatives are suitable for central clearing. A substantial fraction of derivatives are not standardised and cannot be centrally cleared.⁴ These non-centrally cleared derivatives, totalling hundreds of trillions of dollars in notional amounts,⁵ pose the same type of systemic contagion and spillover risks that materialised in the recent financial crisis. Margin requirements for non-centrally cleared derivatives would be expected to reduce contagion and spillover effects by ensuring that collateral is available to offset losses caused by the default of a derivatives counterparty. Margin requirements can also have broader macroprudential benefits, by reducing the financial system's vulnerability to potentially destabilising procyclicality and limiting the build-up of uncollateralised exposures within the financial system.

Promotion of central clearing. In many jurisdictions, central clearing will be mandatory for most standardised derivatives. But clearing imposes costs, in part because CCPs require margin to be posted. Margin requirements on non-centrally cleared derivatives, by reflecting the generally higher risk associated with these derivatives, will promote central clearing, making the G20's original 2009 reform programme more effective. This could, in turn, contribute to the reduction of systemic risk.

BCBS-IOSCO Requirements - Variation Margin

■ Requirements

- On a regular basis (e.g. daily)
- T+1 settlement
- Bilateral full margin (zero threshold)
- Minimum transfer amount no more than €500,000
- Cash is incentivised (directly or via punitive haircuts)

US Rules

When facing another swap entity, only immediately available cash (denominated in USD, another major currency, or the swap settlement currency) can be used.

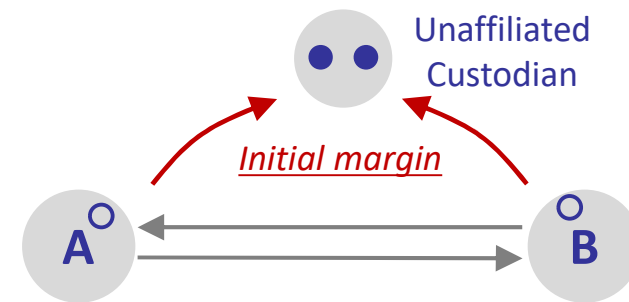
When facing financial end user counterparty, any collateral eligible to IM can be used.

BCBS-IOSCO Requirements - Initial Margin

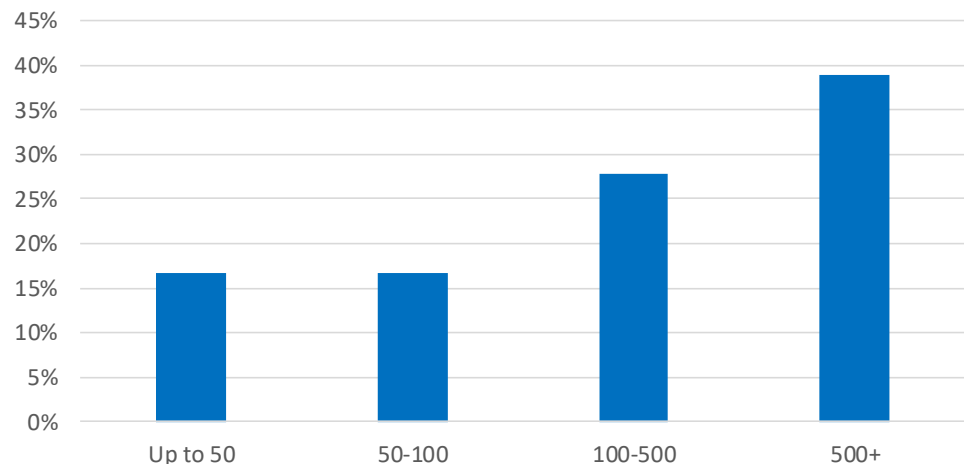
■ Requirements

- 99% confidence level, 10-day time horizon (see later discussion on SIMM)
- Universal IM threshold of 50m Euro below which IM doesn't have to be exchanged
- Independent unaffiliated custodian
(BNY, Euroclear, ...)

■ Phase-in



How many counterparties do you envisage transacting with under bilateral initial margin eventually (~2020)?

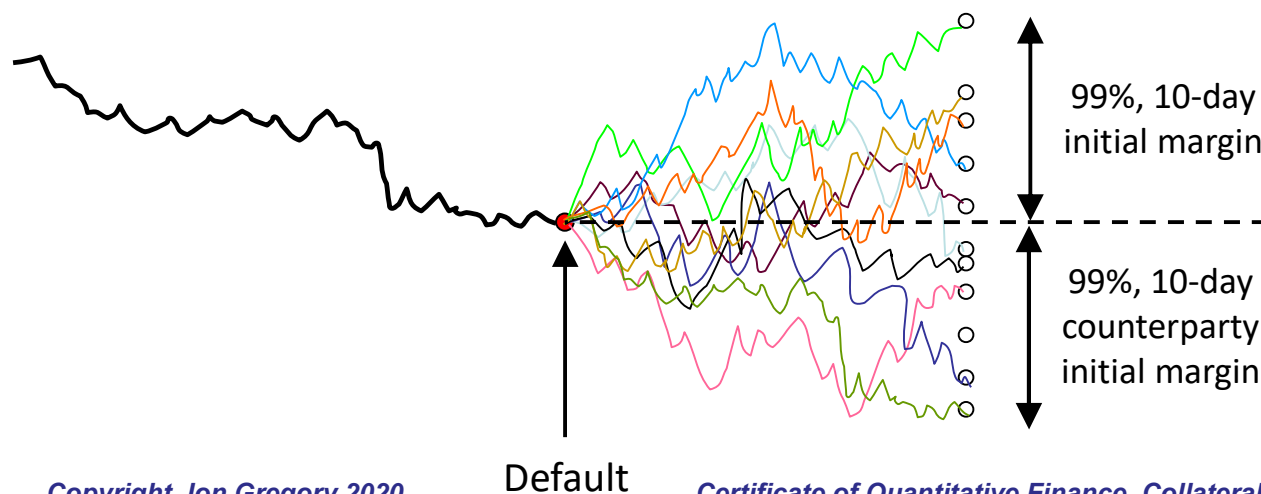


Source: McKinsey / Solum Survey 2017

Monthly non-CCP notional	From	Firms in scope
3 Trillion	1 st September 2016	20
2.25 Trillion	1 st September 2017	26
1.5 Trillion	1 st September 2018	36
0.75 Trillion	1 st September 2019	86
50 billion	1 st September 2021	hundreds
8 Billion	1 st September 2022	thousands

Initial Margin is a Dynamic Quantity

- **Historically initial margin (independent amount) has been rare and when used is often based on very simple metrics (e.g. percentage of notional)**
 - This makes calculation straightforward but it is not very risk sensitive (i.e. does not properly recognise portfolio diversification)
- **In the future, initial margin will be more risk sensitive and dynamic**
 - CCPs use value-at-risk (VAR) type methodologies for OTC derivatives
 - Bilateral markets will use SIMM (standardised initial margin model) which represents a simpler VAR approach based on sensitivities
 - Initial margins can therefore change significantly even in the absence of trading activity



Exchange, OTC Clearing and OTC Bilateral Markets Compared

	Exchange	OTC Cleared	OTC Bilateral
Trading	Exchange	Bilateral	
Clearing	CCP		Bilateral
Netting	Multilateral		Bilateral (ISDA) and Multilateral (compression)
Collateralisation	Strong		Bespoke
Close-out process	Central		Bilateral
Counterparty risk management	Credit limits?		Credit limits CVA desk

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Initial Margin for Cleared and Bilateral OTC Derivatives

	Exchange traded	Central cleared OTC	Bilateral OTC (BCBS-IOSCO)	Bilateral OTC (Independent amount)
Model	SPAN™	Historical Value-at-risk	ISDA SIMM™	Simple (e.g. add-on)
MPR	1-2 days	5-days	10-days	n/a
Recalibration	Periodic	Continuous	Annually	Rare
Threshold	-	-	€50m	n/a
Portfolio	Counterparty (asset class)	CCP (asset class)	Counterparty (asset class)	Trade level

SPAN

■ Standard Portfolio Analysis of Risk (SPAN)

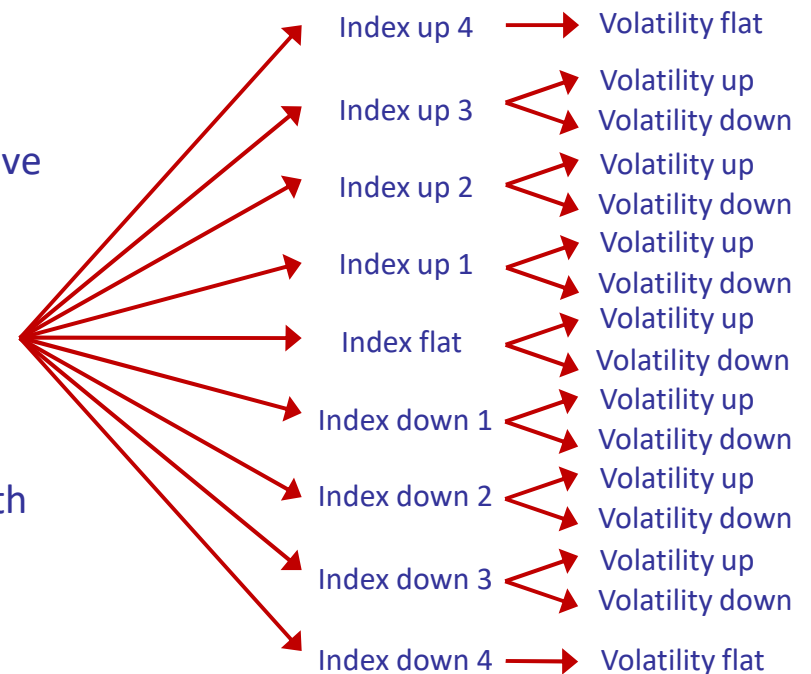
- Developed by CME in the 1980s for exchange-traded products
- By 2008 was licenced by more than 50 exchanges and CCPs globally

■ Methodology

- Evolve individual risk factors (e.g. spot price, volatility) combinatorially
- Shift based on a potential one- or two-day move
- Typically a total of 16 shifts are used (14 reasonable and 2 extreme)

■ Advantages

- Risk sensitive (e.g. NASDAQ position offset with S&P500 position)
- Simple and tractable

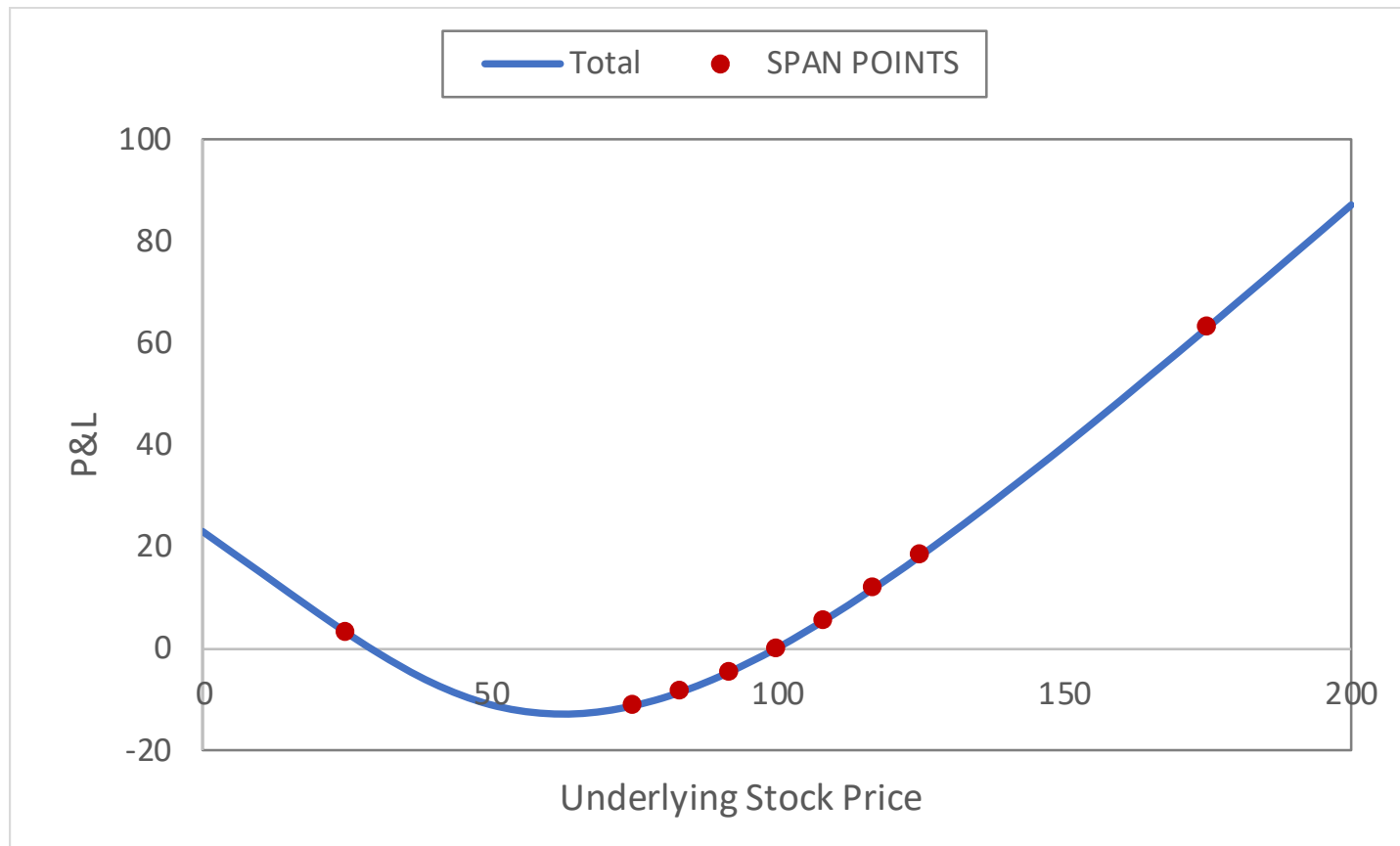


SPAN Example

Scenario	SP Underlying Price Move	Volatility Move	SP Future Gain/Loss	SP Option Gain/Loss	Portfolio Gain/Loss
1	UNCHANGED	UP	0	1,807	1807
2	UNCHANGED	DOWN	0	-1,838	-1,838
3	UP 33%	UP	-7,499	7,899	400
4	UP 33%	DOWN	-7,499	5,061	-2,438
5	DOWN 33%	UP	7,499	-3,836	3,663
6	DOWN 33%	DOWN	7,499	-8,260	-761
7	UP 67%	UP	-15,001	14,360	-641
8	UP 67%	DOWN	-15,001	12,253	-2,748
9	DOWN 67%	UP	15,001	-8,949	6,052
10	DOWN 67%	DOWN	15,001	-13,980	1,021
11	UP 100%	UP	-22,500	21,107	-1,393
12	UP 100%	DOWN	-22,500	19,604	-2,896
13	DOWN 100%	UP	22,500	-13,455	9,045
14	DOWN 100%	DOWN	22,500	-18,768	3,732
15	UP 300%	UNCHANGED	-22,275	21,288	-987
16	DOWN 300%	UNCHANGED	22,275	-9,160	13,115
Largest Potential Loss = SPAN Risk					13,115

Source: CME

SPAN and Options



Initial Margin Models and Procyclicality


- **CCP initial margins are potentially procyclical due to:**
 - Use of rolling historical data window
 - High confidence levels
 - Volatility scaling
- **For example, LCH.Clearnet's PAIRS**
 - *"PAIRS is an expected shortfall value-at-risk (VaR) model based on filtered historical simulation incorporating volatility scaling. The model uses either ten (OTC) or five (Exchange Traded) years of historical market data to simulate changes in portfolio value from which an estimate of the potential loss distribution is calculated."*
 - Initial margin is the average of the six worst scenarios out of 2,500
 - This is the expected shortfall with a confidence level of $\left(1 - \frac{6}{2500}\right) = 99.76\%$

Historical Simulation Formula

■ Procedure

- Simulate risk factors from today (n) to tomorrow (n+1) using historical changes

$$\underbrace{v_{n+1}^i}_{\text{Simulation of risk factor for } i^{\text{th}} \text{ scenario}} = v_n \times \frac{v_i}{v_{i-1}} \quad \left. \vphantom{\frac{v_i}{v_{i-1}}} \right\} \begin{array}{l} \text{Relative change in} \\ \text{risk factor in the} \\ \text{past (time } i \text{)} \end{array}$$

 *Risk factor now*

- Can you think of another way to do this?

Volatility Scaling

- Scale historical movements by the ratio of current volatility to the past volatility

$$v_{n+1}^i = v_n \left(1 + \underbrace{\frac{(v_i - v_{i-1})}{v_{i-1}}}_{\text{Relative change in risk factor}} \underbrace{\frac{\sigma_{n+1}}{\sigma_i}}_{\text{Relative change in volatility estimate}} \right)$$

- “A EWMA (Exponentially Weighted Moving Average) volatility model is used as the forecasting model to provide volatility forecasts ‘as if’ computed on each day in the time series. The percentage changes in these conditional volatility forecasts are used to adjust historical shocks to account for the change in the conditional volatility forecast between the date of the shock and ‘today’” (CME)
- What are the strengths and weaknesses of this?

Challenges for OTC Initial Margin Calculations

■ Data window

- A long time horizon may be irrelevant but short time horizons may lead to procyclicality as events “drop out” of the data set
- Scaling methods such as EWMA (more weight to most recent observations) are procyclical

■ Relative or absolute returns?

- One or the other may be conservative depending on if rates are low or high

■ Risk measure

- A more extreme scenario will give rise to greater procyclicality
- VAR has some unpleasant features (e.g. subadditivity is not guaranteed)

■ Portfolio size

- A bigger portfolio should be penalized?

■ Linkage to credit quality

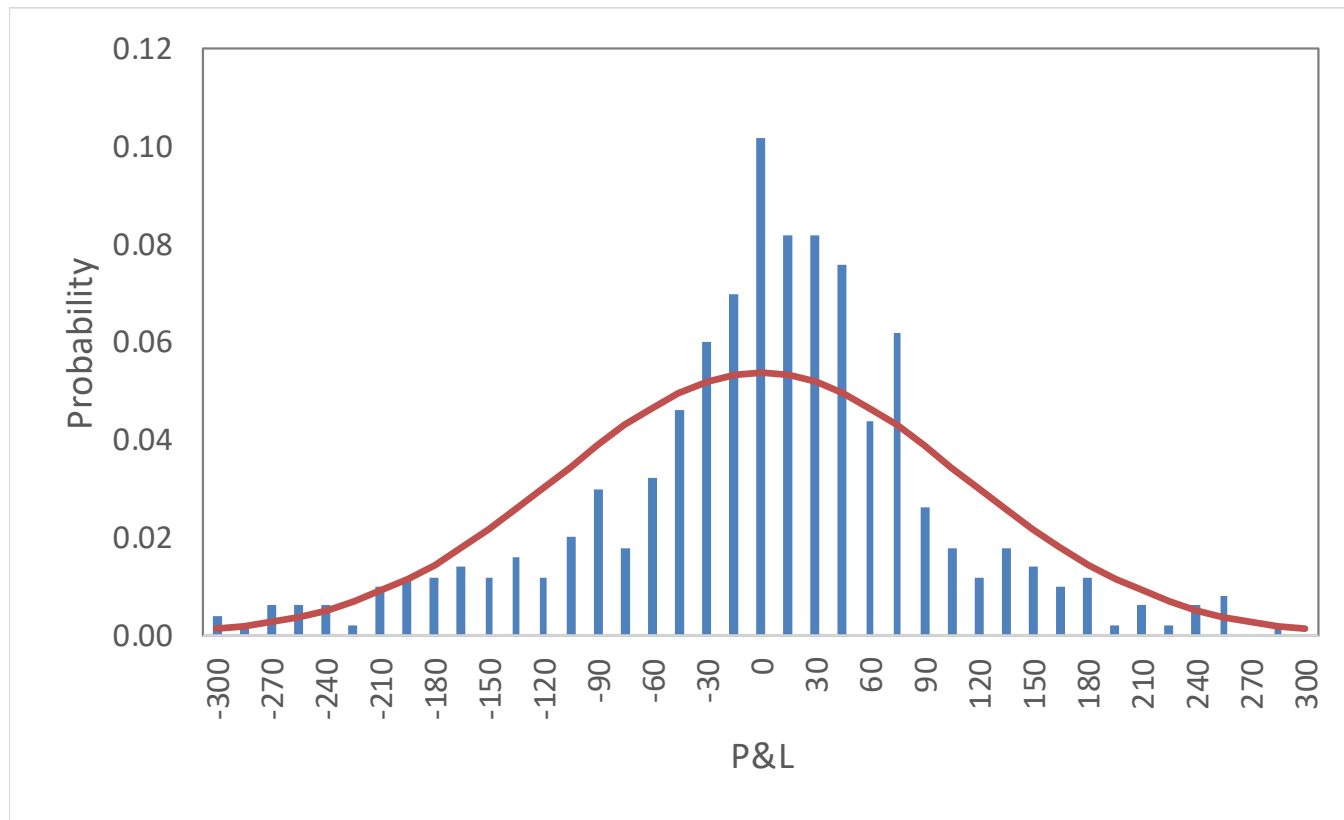
- A weaker clearing member should pay more
- But this can lead to cliff edge effects

Features of SIMM

- **Historical simulations are very complex due to:**
 - Data set being used (time period, period of stress)
 - Valuation of transactions in the future
 - Methodology (relative/absolute returns)
 - Calculation (VAR/ES, confidence level, time horizon)
- **In CCP situations this is not problematic (the CCP is in charge) but could lead to many disagreements/disputes in bilateral markets**
- **Hence SIMM simplifies the IM calculation and avoids historical simulation**
 - Can be seen as a variance-covariance style approach using delta-gamma-vega approximations for valuation
 - The only thing counterparties will need to agree on is the sensitivities (quite a big deal in itself) and trade population

Example (Long Position on S&P 500 Index)

$$VAR_{\alpha} = \underbrace{\Phi^{-1}(\alpha)}_{\text{Confidence level}} \times \underbrace{\sqrt{10/250}}_{\text{Time horizon}} \times \sigma_P$$



Calculating the Portfolio Standard Deviation

- We can calculate the portfolio standard deviation by:

$$\sigma_P = \sum_{i=1}^n \sum_{j=1}^n w_i w_j \rho_{ij} \sigma_i \sigma_j = \sum_{i=1}^n w_i^2 \sigma_i^2 + 2 \sum_{i=1}^n \sum_{j=i+1}^n w_i w_j \rho_{ij} \sigma_i \sigma_j$$

- In matrix form:

$$(w_1 \quad \dots \quad w_n) \begin{pmatrix} \sigma_1^2 & \dots & \rho_{1n} \sigma_1 \sigma_n \\ \dots & \dots & \dots \\ \rho_{1n} \sigma_n \sigma_1 & \dots & \sigma_n^2 \end{pmatrix} \begin{pmatrix} w_1 \\ \vdots \\ w_n \end{pmatrix} = \mathbf{w}^T \mathbf{\Sigma} \mathbf{w}$$

- What is a potential problem with this?

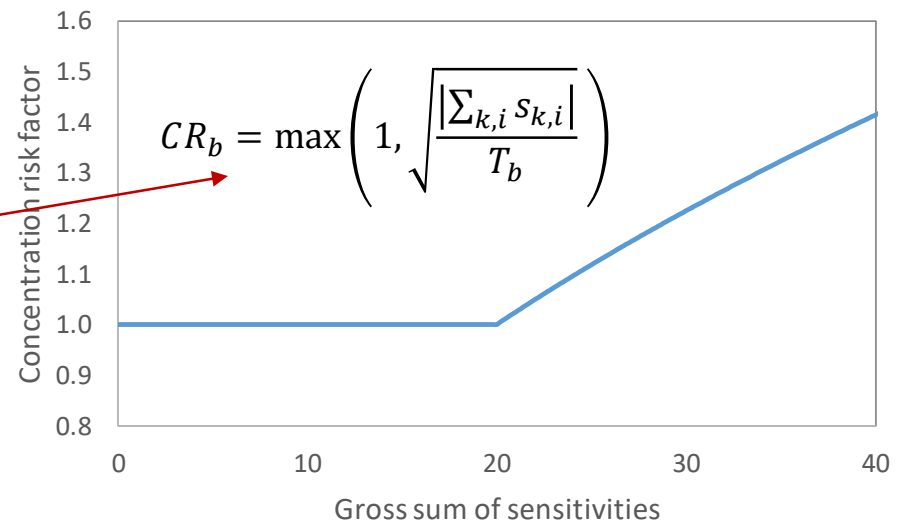
Variance-Covariance Approach – Valuation

- The term w_i represents the sensitivity to the i th risk factor
- These sensitivities are most obviously approximated by Greeks
 - Delta
 - Gamma (curvature)
 - Vega
- Avoids counterparties needed to perform full revaluation and also agree on these valuations
- The second two are more important for balanced portfolios and option positions
 - Note that a lot of the 'delta' can be cleared (e.g. interest rate swaps) but the Curvature and Vega cannot (e.g. interest rate swaptions)

Risk Factor Sensitivity (I)

- Illustration for interest rate positions (others asset classes are simpler due to no curve sensitivity)
- Starting point is net sensitivity to each risk factor

$$WS_{k,i} = \underbrace{RW_k}_{\text{Risk weight}} \times \underbrace{s_{k,i}}_{\text{Sensitivity to } i^{\text{th}} \text{ curve and } k^{\text{th}} \text{ tenor (1 bp)}} \times \underbrace{CR_b}_{\text{Concentration risk factor}}$$



	2w	1m	3m	6m	1y	2y	3y	5y	10y	15y	20y	30y
Regular	114	115	102	71	69	52	50	51	51	51	54	62
Low volatility	33	20	10	11	14	20	22	20	20	21	23	27
High volatility	91	91	95	88	90	101	101	99	108	100	101	101

Note: major currencies except JPY all have the same volatility

These are ISDA SIMM v2.1 numbers which came into effect on 1st December 2018

Aggregation Across Risk Factors - Tenor

- Weighted sensitivities are aggregated across sub-curve and tenor

$$K = \sqrt{\sum_{i,k} W S_{k,i}^2 + \sum_{i,k} \sum_{(j,l) \neq (i,k)} \rho_{k,l} \phi_{i,j} W S_{k,i} W S_{l,j}}$$

Sub-curve correlation (98%)
Tenor correlation

Note: correlations are the same for all currencies and curves

	2w	1m	3m	6m	1y	2y	3y	5y	10y	15y	20y	30y
2w	100%	63%	59%	47%	31%	22%	18%	14%	9%	6%	4%	5%
1m		100%	79%	67%	52%	42%	37%	30%	23%	18%	15%	13%
3m			100%	84%	68%	56%	50%	42%	32%	26%	24%	21%
6m				100%	86%	76%	69%	60%	48%	42%	38%	33%
1y					100%	94%	89%	80%	67%	60%	57%	53%
2y						100%	98%	91%	79%	73%	70%	66%
3y							100%	96%	87%	81%	78%	74%
5y								100%	95%	91%	88%	84%
10y									100%	98%	97%	94%
15y										100%	99%	97%
20y											100%	99%
30y												100%

Aggregation Across Risk Factors - Currency

- Then aggregation across currency

$$DeltaMargin_{IR} = \sqrt{\sum_b K_b^2 + \sum_c \sum_{c \neq b} \gamma_{bc} g_{bc} S_b S_c}$$

*Currency
correlation*

$$\gamma_{bc} = 21\%$$

$$S_b = \max \left(\underbrace{\min \left(\sum_{i,k} W S_{k,i}, K_b \right)}_{\text{Avoids benefit from high correlation for offsetting positions}}, -K_b \right)$$

*Avoids benefit from high correlation
for offsetting positions*

$$g_{bc} = \frac{\min(CR_b, CR_c)}{\max(CR_b, CR_c)}$$

In This Lecture

- i) Derivatives as Financial Weapons of Mass Destruction*
- ii) Risk Mitigation in Derivatives*
- iii) Collateral in OTC Derivatives*
- iv) Central Clearing*
- v) Bilateral Margin Requirements*
- vi) Initial Margin Methodologies*
- vii) The Dangers of Clearing and Overcollateralisation*

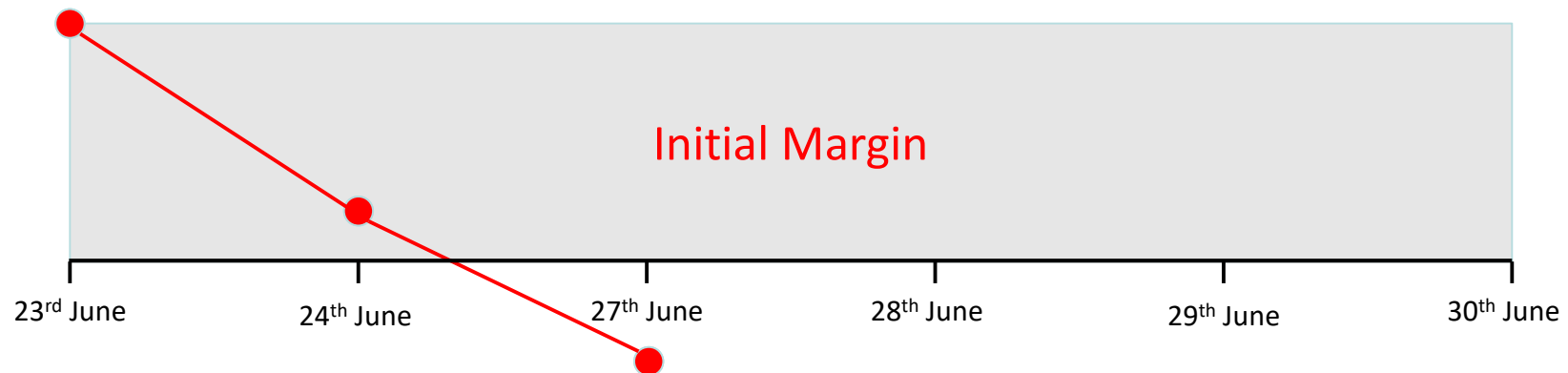
Initial Margin Models and Procyclicality

- **CCP initial margins are potentially procyclical due to:**
 - Use of rolling historical data window
 - High confidence levels
 - Volatility scaling
- **For example, LCH.Clearnet's PAIRS**
 - *"PAIRS is an expected shortfall value-at-risk (VaR) model based on filtered historical simulation incorporating volatility scaling. The model uses either ten (OTC) or five (Exchange Traded) years of historical market data to simulate changes in portfolio value from which an estimate of the potential loss distribution is calculated."*
 - Initial margin is the average of the six worst scenarios out of 2,500
 - This is the expected shortfall with a confidence level of $\left(1 - \frac{6}{2500}\right) = 99.76\%$

Initial Margin Changes – Brexit Vote Example (I)

- Initial margin is taken by CCPs to cover at least a 99% worst case scenario over a 5-day period

- What happened to a GBP swap after Brexit?



- It didn't even seem as if there was enough initial margin to cover a 2-day move
- This does not consider the possible costs of closing out this position (luckily no-one defaulted)
- Initial margin requirements then quickly increased by around 25% (within a week) as a result of the Brexit vote

Initial Margin Changes – Brexit Vote Example (II)

- Changes in initial margin for interest rate swaps in different currencies

IRS 10Y 100m	Par	DV01 (k)	LCH IM	CME IM
EUR Pay	-0.21%	1	4%	0%
EUR Rec	-0.21%	-1	3%	0%
GBP Pay	-0.49%	2	21%	52%
GBP Rec	-0.49%	-2	9%	25%
USD Pay	-0.23%	3	5%	3%
USD Rec	-0.23%	-3	2%	0%

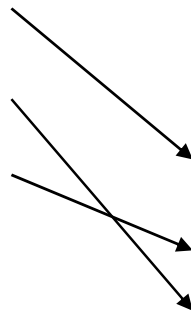
Source: Clarus Financial Technology

Understanding the Impact of Brexit Vote (I)

- PAIRS (LCH) (in 2016) looked at the six worst scenarios from the last ten years
- For a pay fixed 10-year GBP swap, these are:

	Date	P&L
1 st worst	26 th November 2008	(3.49%)
2 nd worst	25 th November 2008	(3.40%)
3 rd worst	31 st October 2008	(3.39%)
4 th worst	27 th October 2008	(3.09%)
5 th worst	3 rd November 2008	(2.92%)
6 th worst	8 th October 2014	(2.78%)
Initial margin		3.18%

	Date	P&L
1 st worst	23 rd June 2016	(4.74%)
2 nd worst	22 nd June 2016	(3.97%)
3 rd worst	26 th November 2008	(3.94%)
4 th worst	31 st October 2008	(3.86%)
5 th worst	25 th November 2008	(3.84%)
6 th worst	21 st June 2016	(3.69%)
Initial margin		4.01%



Understanding the Impact of Brexit Vote (II)

■ What about receive fixed?

	Date	P&L			Date	P&L
Scenario 1	17 th June 2013	(4.48%)	→	Scenario 1	17 th June 2013	(5.01%)
Scenario 2	14 th June 2013	(3.44%)	→	Scenario 2	14 th June 2013	(3.94%)
Scenario 3	18 th June 2013	(3.35%)	→	Scenario 3	18 th June 2013	(3.81%)
Scenario 4	27 th December 2012	(2.72%)	→	Scenario 4	27 th December 2012	(3.13%)
Scenario 5	30 th January 2015	(2.70%)	→	Scenario 5	30 th January 2015	(3.10%)
Scenario 6	30 th April 2009	(2.58%)	→	Scenario 6	30 th April 2009	(2.90%)
Initial margin		3.21%		Initial margin		3.65%

- Question: why does the IM still increase?

Two CCP Defaults Compared

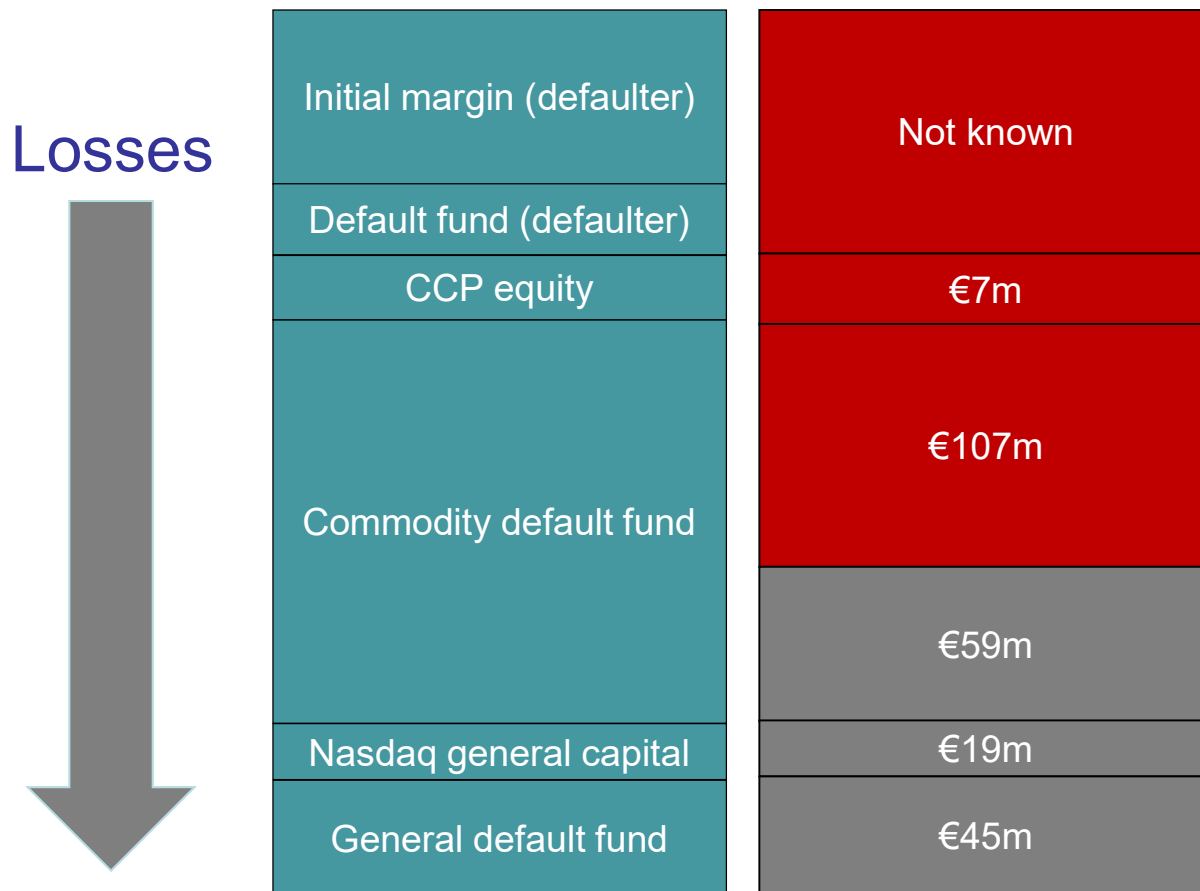
	SwapClear	Nasdaq
Who?	Lehman Brothers	Einar Aas
What?	Large investment bank	Norwegian proprietary trader
When?	September 2008	September 2018
CCP?	LCH (London Clearing House) SwapClear (UK)	Nasdaq Clearing AB (Sweden)
Portfolio?	About 66,000 OTC derivatives trades (interest rate) with \$9 trillion total notional	Exchange traded commodities
Loss to CCP?	Zero	€7 million
Loss to CCP members?	Zero	€107 million

Nasdaq Case Study

- **Default fund loss of €107 million (after €7 skin-in-the-game)**
- **Key points:**
 - Market move 17 times that of a 'normal' day
 - But only 39% larger than initial margin held (no concentration add-on)
 - Two-thirds of default fund wiped out (€166 million total)
 - Losses increased during auction process which was closed among four (out of 166) member firms to avoid the news impacting the market during the bidding process
 - Nasdaq asked members for € 100 million to replenish the default fund

Nordic power trader's loss costs Nasdaq and members 114 million euros

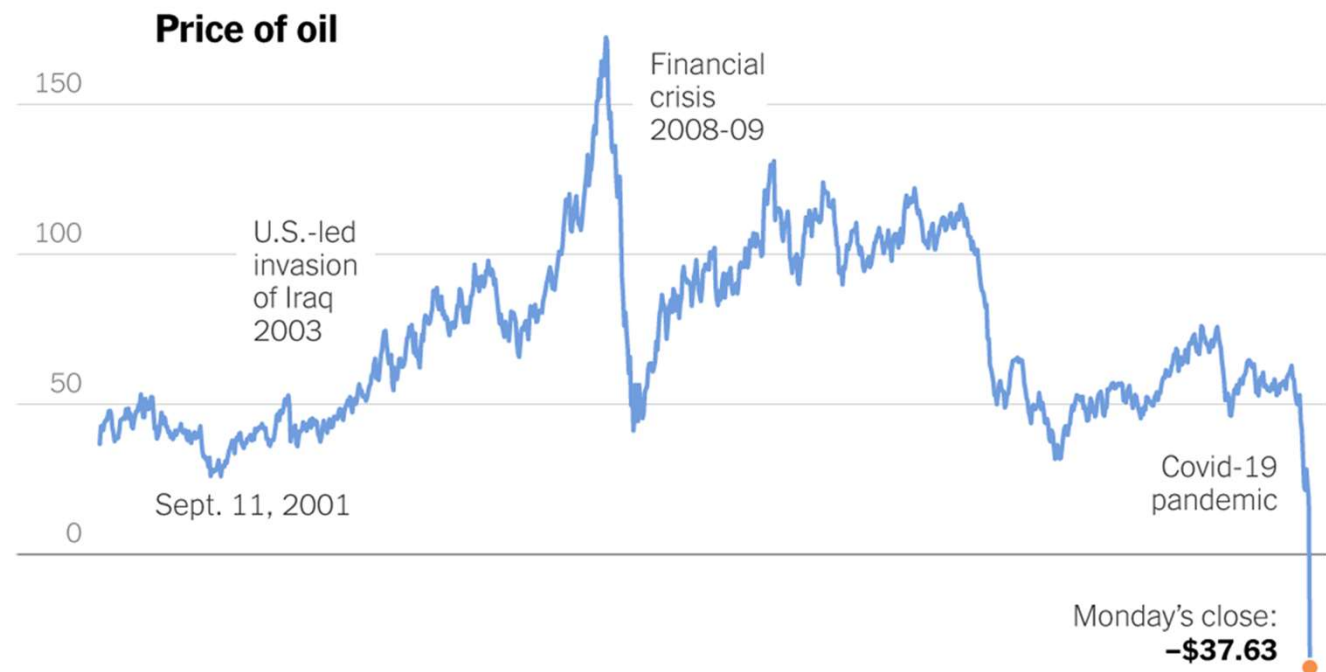
Default Fund – Nasdaq and Einar Aas (2018)



Oil Price Example

CME was ill-prepared for negative oil prices, FCMs say

Bourse draws criticism over timing of options model change; delay in sending key margin file



Summary

- **Collateralisation resolves some of the issues with Derivatives being “Financial Weapons of Mass Destruction”**
 - Agreement on valuation for variation margin purposes
 - Multilateral netting (reduces “daisy-chain risk”?)
 - Reduction of credit risk losses (especially with initial margin) that is intended to reduce systemic risk
- **This is a major reason why regulation is enforcing increased collateralisation via central clearing and bilateral margin requirements**
- **However,**
 - Some users of OTC derivatives cannot easily post (cash) collateral
 - Collateral also creates other risks (e.g. liquidity risk)
 - Central clearing is by no means a panacea