OFFICE OF FINANCIAL RESEARCH

Contagion in CDS Markets

Mark Paddrik*, Sriram Rajan*, and H. Peyton Young*

RiskLab/BoF/ESRB Conference on Systemic Risk Analytics, October 5-7, 2016

* Office of Financial Research
** University of Oxford & London School of Economics

Contagion in CDS Markets

Mark Paddrik[†] Sriram Rajan[†] H. Peyton Young[†‡]

[†]Office of Financial Research, U.S. Treasury
[‡]University of Oxford & London School of Economics

RiskLab/BoF/ESRB Conference on Systemic Risk Analytics

October 5-7, 2016

Motivation

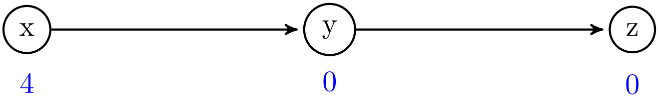
- Margin and credit derivatives exposures are important:
    - AIG in 2008 was a major counterparty; its inability to post collateral had downstream systemic consequences.
    - Credit default swaps (CDS) were critical in 2008-2009; threatened financial stability through asymmetric and off-balance sheet exposures.
- Contagion does not require default. Delayed or uncertain margin payments can impose funding stresses which lead to runs. This paper addresses this risk.

This Paper

- We use detailed DTCC CDS data to construct the network of exposures in this market and test the potential for contagion.
- We estimate variation and initial margins as of the 2015-CCAR stress test.
- For each firm, we estimate the expected stress they produce (and receive) under a shock.
  - Collateral payment stress are calculated over a range of behavioral responses under the shock.
  - We distinguish between initial and equilibrium stress effects that arise from network contagion.

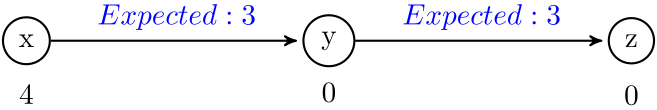
Example of Payment Contagion

- We are concerned with the flow of payments between firms and how contagion may propagate in chains. A simple example:



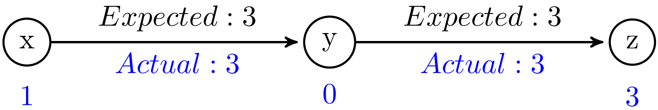
Example of Payment Contagion

- We are concerned with the flow of payments between firms and how contagion may propagate in chains. A simple example:



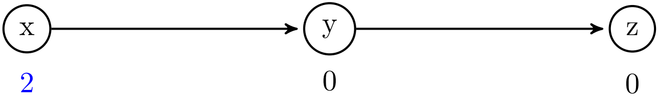
Example of Payment Contagion

- We are concerned with the flow of payments between firms and how contagion may propagate in chains. A simple example:



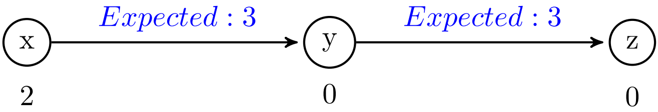
Example of Payment Contagion

- We are concerned with the flow of payments between firms and how contagion may propagate in chains. A simple example:



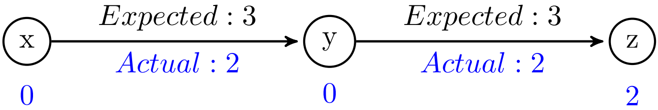
Example of Payment Contagion

- We are concerned with the flow of payments between firms and how contagion may propagate in chains. A simple example:



Example of Payment Contagion

- We are concerned with the flow of payments between firms and how contagion may propagate in chains. A simple example:



Literature

- Network structure and the risk of contagion
    - Allen and Gale (2000); Freixas et al. (2000); Gai et al. (2011); Cont et al. (2013);
- Central counterparty clearing and margin payments
    - Cont and Kokholm (2014); Cont and Minca (2014); Duffie et al. (2015)
- Credit default swap market and assessing systemic risk

  Brunnermeier et al. (2013); Clerc et al. (2013); Peltonen et al. (2014); Vuillemey and Peltonen (2015);

Contributions

1. Our work documents the critical role of non-CCP-members in contagion.
2. This contrasts with the traditional focus on risks posed by the CCP and its members.
3. We quantify the network participants' marginal contribution of participants to systemic risk.

Outline

Background: Credit Default Swaps

Variation margin

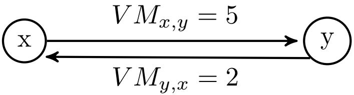
- CDS are insurance contracts which pay out on contingent default or expire at term.
- In the interim, CDS are marked-to-market daily and create bilateral exchanges of **variation margin (VM)**.
- VM may be levied within a one-hour window (ICE Clear Credit).

Systemic credit shocks

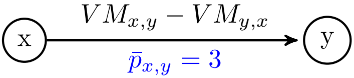
- Credit shocks increase bilateral VM flows between exposed counterparties.
- We adopt the Federal Reserve's CCAR Global Market Shock as a systemic disruption. 2015 CCAR Global Market Shock
- How are the VM flows characterized?

Variation Margin Payments

- By using the detailed the DTCC CDS data and evaluating each positions value for a given date, we can to construct the network of expected VM payments given the CCAR market shock.
- Price $\sim$ 6.3 million exposures of $\sim$ 1000 firms over $\sim$ 3000 reference entities in late 2014. Data



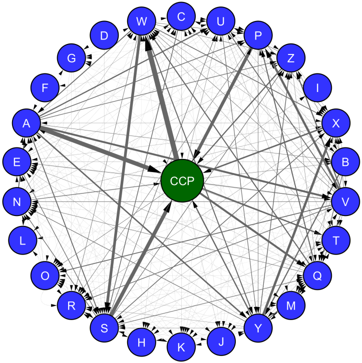
(a) Initial state described by $VM_{x,y} = 5$, $VM_{y,x} = 2$;



(b) $\bar{p}_{x,y} = VM_{x,y} - VM_{y,x}$, is the net VM payment owed by x to y.

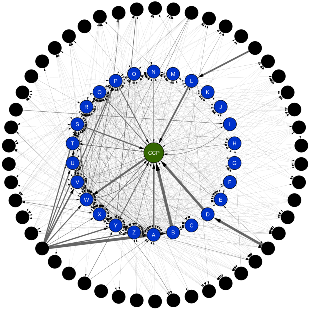
Variation Margin Payment: CCP and Members

- This network shows the flow of VM payments among clearing members and the CCP for the 2015 CCAR.
- Although inter-member payments may be large, the largest payments are those between members and the CCP.
- This diagram supports the popularly held view of CCP importance.



Variation Margin Payment: + Nonmembers

- In addition, the network consists of many other entities.
  - These include hedge funds, asset managers, insurance companies, pension funds, among others.
- Nonmembers clear through members (futures clearing merchants).
  - In this way, nonmembers create indirect exposures with the CCP.
- Nonmember-CCP exposures are in some cases very large.
  - Magnitude & direction are consequential for contagion.



Initial Stress: CCP and Members

If the sum of firm i's obligations, p_i, is *positive*, this will cause an **initial stress** on the payment network.

$$\bar{p}_i = \sum_{j \neq i} \bar{p}_{ij}.$$

Table: Variation Margin Payments and Initial Stress for CCP Member Firms (millions of dollars)

Firms	Variation Margin Owed By	Variation Margin Owed To	Initial Stress
A-E	2,917	1,287	1,630
F-J	35	46	8
K-O	439	571	27
P-T	5,135	4,399	1131
U-Z	7,614	8,449	532
CCP	8,602	8,602	-

Note: Firms are arranged in groups of five or six to maintain anonymity. Within each group some firms are under stress, hence the total stress for each group is positive.
Source: Authors' calculations using Depository Trust & Clearing Corporation data.

Initial Stress: Nonmembers

Table: Top 26 Nonmember Firms Ordered by Initial Stress (millions of dollars)

Firms	Variation Margin Owed By	Variation Margin Owed To	Initial Stress
I-V	10,296	830	9,466
VI-X	2,707	1,771	936
XI-XV	457	77	380
XVI-XX	1,254	967	287
XXI-XXVI	395	92	303

Source: Authors' calculations using Depository Trust & Clearing Corporation data.

- The table ranks firms by initial stress, not size.
- Size does not necessarily imply contagion risk: some of the largest firms have little or no initial stress.
- Members tend to have balanced risk exposures.

Payment Buffers

Initial Margin and Liquidity Buffers are used to pay outgoing VM obligations and protect against the risk of incoming VM obligations not being paid:

1. **CCP Member Initial Margins:** buffer collected by a CCP member from a counterparty and held in escrow, to cover potential stress in payments by that counterparty.

2. **Nonmember Initial Margins** are transmitted by the clearing member to the CCP. EU/US rules differ on where the margin actually resides; unimportant distinction for our work.

All collateral used as payment buffers must be cash or sovereign securities.

Payment Buffers

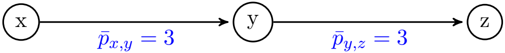
Initial Margin and Liquidity Buffers are used to pay outgoing VM obligations and protect against the risk of incoming VM obligations not being paid:

1. **CCP Member Initial Margins:** buffer collected by a CCP member from a counterparty and held in escrow, to cover potential stress in payments by that counterparty.
2. **Nonmember Initial Margins** are transmitted by the clearing member to the CCP. EU/US rules differ on where the margin actually resides; unimportant distinction for our work.
3. **Liquidity Buffers:** capital maintained by market participants to cover their own VM payment obligations. Little is publicly known about these, except for the CCP.

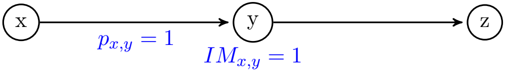
All collateral used as payment buffers must be cash or sovereign securities.

Role of Initial Margin in Contagion

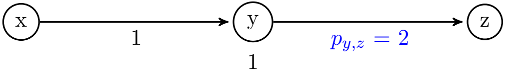
- Insufficient **initial margin** (IM) propagates contagion.



(a) Suppose x owes 3 to y and y owes 3 to z. Recall $\bar{p}_{x,y} = VM_{x,y} - VM_{y,x}$.



(b) Suppose x can only pay 1 and x has 1 unit of IM in escrow with y. If $p_{x,y} \leq \bar{p}_{x,y}$ then y uses min($\bar{p}_{x,y}$ - $p_{x,y}$, $IM_{x,y}$) to cover payment delays.



(c) If $p_{x,y} + min(\bar{p}_{x,y} - p_{x,y}, IM_{x,y}) < \bar{p}_{y,z}$ then y will need to reduce $p_{y,z}$.

Initial Margin Estimation

We follow a standard value-at-risk metric for estimating initial margin (IM).

- We compute the change in portfolio value over a 10 day interval using a 1000 day historical window.
- We take the 99.6% percentile of this distribution of IM.
- This approach corresponds to market convention for IM calculations.
- For the CCP, we use publicly reported IM.

Details

Contagion Model

The set-up is based on the framework of Glasserman and Young (2015), which in turn builds on the model of Eisenberg and Noe (2001).

- Given a shock x, we can represent the VM payment obligations by a matrix $\bar{P}(x) = (\bar{p}_{ij}(x))$, where $\bar{p}_{ij}(x)$ is the net amount of VM owed by i to j.
- The total obligations of i are

$$\bar{p}_i = \sum_{j \neq i} \bar{p}_{ij}. \tag{1}$$

- The total incoming payments to node i plus the initial margin collected is

$$\sum_{k \neq i} \left((p_{ki} + c_{ki}^{IM}) \wedge \bar{p}_{ki} \right). \tag{2}$$

- The difference between $\bar{p}_i$ and $\sum_{k \neq i} (p_{ki} + c_{ki}^{IM})$, if positive, is the **Equilibrium Stress** at i:

$$s_i = \sum_{k \neq i} \bar{p}_{ik} - \sum_{k \neq i} \left((p_{ki} + c_{ki}^{IM}) \wedge \bar{p}_{ki} \right). \tag{3}$$

CCP Clearing

Liquidity Buffers

We define a **transmission parameter**, τ for each firm i.

- $\tau_i \geq 0$ measures the extent to which the stress at i is transmitted to i's counterparties:
  - $\tau_i = 0$: stress is met from cash assets in i's treasury.
  - $\tau_i = 0.5$: half of the stress is met and half is transmitted.
  - $\tau_i > 1$: i holds back some outgoing payments given the uncertainty about incoming payments.

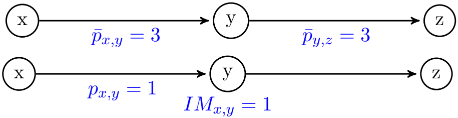
The **relative liability** of node i to node j is

$$a_{ij} = \bar{p}_{ij} / \bar{p}_i. \tag{4}$$

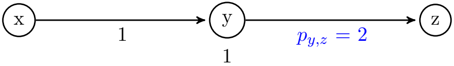
Assume that the stress at i, s_i, is transmitted to i's counterparties in proportion to i's obligations. Then the actual payment from i to j takes the form:

$$p_{ij} = \left[\bar{p}_{ij} - \tau_i a_{ij} s_i\right]_+ . \tag{5}$$

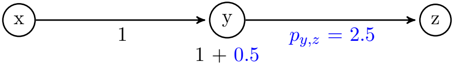
Role of Liquidity Buffers in Contagion



(a) Once again suppose x owes 3 to y and y owes 3 to z, but x can only pay 1 and x has 1 unit of IM in escrow with y.



(b) As $p_{x,y} + min(\bar{p}_{x,y} - p_{x,y}, IM_{x,y})$ is less than $\bar{p}_{y,z}$, y will need to reduce $p_{y,z}$ to 2, making $s_y = 1$.



(c) Now we suppose that y has some liquidity buffer, such that $\tau_y = 0.5$, so y can pay $\tau_y s_y = 0.5$ from its liquidity buffer.

Contagion Model

As the value of τ varies, so does the stress that each firm transmits through payment reductions.

- At the equilibrium stress $(s_0, ..., s_n)$ we can determine the total reduction of payments each firm will make:

$$d_i = \bar{p}_i - p_i = \tau_i s_i \wedge \bar{p}_i, \quad \tau_i \geq 0. \tag{6}$$

- The total amount of reduction of payments of all firms is:

$$D = \sum_i d_i. \tag{7}$$

- The total amount of reduction of payments, net of initial margin stocks, at the equilibrium stress is:

$$\tilde{D} = \sum_{0 \leq i,j \leq n} [\bar{p}_{ij} - (p_{ij} + c_{ij}^{IM})]_+, \quad \tau_i \geq 0. \tag{8}$$

Equilibrium Stress

Table: Equilibrium Stress when all $\tau_i = 1$

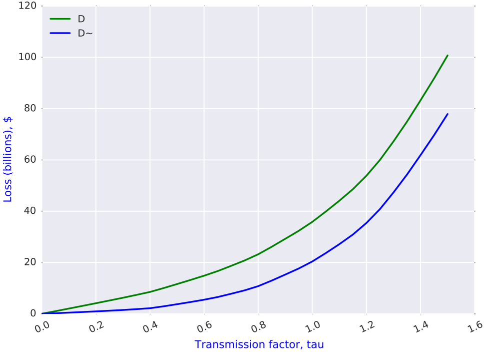
	Initial Stress	Equilibrium Stress
CCP	-	1,331
Members		
A-E	1,630	3,236
F-J	8	45
K-O	27	3,703
P-T	1131	6,978
U-Z	532	7,993
Nonmembers		
I-V	9,466	12,869
VI-X	936	1,195
XI-XV	380	484
XVI-XX	287	564
XXI-XXVI	303	364

Source: Authors' calculations using Depository Trust & Clearing Corporation data.

- Stresses are large: cash reserves of all broker-dealers combined is around \$25 billion (Focus Reports, 2015).

Contagion as a Function of τ

The overall impact of τ on the amount of contagion in the network is shown in the figure below.



Source: Authors' calculations using data provided by DTCC.

- When $\tau = 1$, the initial stress, summed over all nodes, is about \$36 billion of which about \$23 billion can not be cover by initial margins.
- When $\tau = 1.5$, each node (except the CCP) does some precautionary delaying of margin payments, leading to nearly \$100 billion in delinquent payments.

Initial Margin Policy Change

Starting in September 2016, IM must be posted by both counterparties in all non-centrally cleared CDS transactions using a 10-day margin period of risk (BCBS and IOSCO (2015)).

- Undoubtedly there will be changes to the network of exposures.
- We shall examine what would have happened if the new requirements had been in place when the CCAR shock was applied given the network of exposures as it existed at the time.
- We follow market conventions regarding the payment and receipt of initial margin. A participant may solely pay, solely receive, or both receive and pay initial margin, depending on its type (Duffie, 2015).

Table: Initial Margin Payment Matrix

	$\mathbb{I}_{x:y}$	**Receiver** (y)				
		CCP	Dealer	Commercial Bank	HF/Asset Manager	Other
Payer (x)	CCP	No	No	No	No	No
	Dealer	Yes	No	No	No	No
	Commercial Bank	Yes	Yes	No	No	No
	HF/Asset Manager	Yes	Yes	Yes	No	No
	Other	Yes	Yes	Yes	No	No

Initial Margin Policy Change

Starting in September 2016, IM must be posted by both counterparties in all non-centrally cleared CDS transactions using a 10-day margin period of risk (BCBS and IOSCO (2015)).

- Undoubtedly there will be changes to the network of exposures.
- We shall examine what would have happened if the new requirements had been in place when the CCAR shock was applied given the network of exposures as it existed at the time.
- We follow market conventions regarding the payment and receipt of initial margin. A participant may solely pay, solely receive, or both receive and pay initial margin, depending on its type (Duffie, 2015).

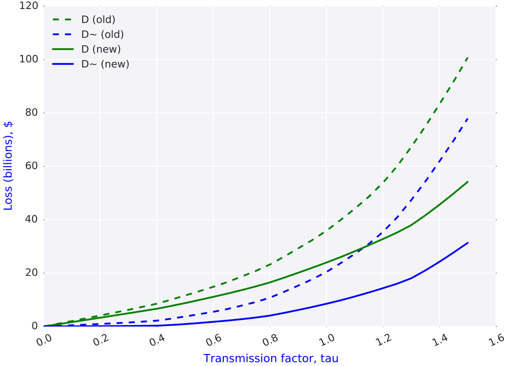
Table: Initial Margin Payment Matrix

	$\mathbb{I}_{x:y}$	**Receiver** (y)				
		CCP	Dealer	Commercial Bank	HF/Asset Manager	Other
Payer (x)	CCP	No	No	No	No	No
	Dealer	Yes	**Yes**	**Yes**	No	No
	Commercial Bank	Yes	Yes	**Yes**	No	No
	HF/Asset Manager	Yes	Yes	Yes	No	No
	Other	Yes	Yes	Yes	No	No

Contagion as a Function of Policy Change

In comparison with previous figure we find that there is a sizable reduction in the payment stress throughout the system.

- When $\tau \leq 1$ almost all of the stress is covered by collected IM, thus reducing the amount of contagion.



Source: Authors' calculations using data provided by Depository Trust & Clearing Corporation.

Conclusion

- The CCP, though at the center of the network, is not the main source of systemic risk.
- The degree of contagion depends on behavioral responses under stress, including precautionary hoarding.
- The framework is very general and can be applied to other markets, eg. interest rate swaps and repo.

References I

Allen, F. and Gale, D. (2000). Financial contagion. *Journal of Political Economy*, 108(1):1–33.

BCBS and IOSCO (2015). Margin requirements for non-centrally-cleared derivatives. Technical report, BIS and OICU-IOSCO, Basil, Switzerland.

Brunnermeier, M., Clerc, L., and Scheicher, M. (2013). Assessing contagion risks in the CDS market. Banque de France Financial Stability Review 17.

Clerc, L., Gabrieli, S., Kern, S., and El Omari, Y. (2013). Assessing contagion risk through the network structure of CDS exposures on European reference entities. In *AFSE Meeting 2013*.

Cont, R. and Kokholm, T. (2014). Central clearing of otc derivatives: bilateral vs multilateral netting. *Statistics & Risk Modeling*, 31(1):3–22.

Cont, R. and Minca, A. (2014). Credit default swaps and systemic risk. *Annals of Operations Research*, pages 1–25.

Cont, R., Moussa, A., and Santos, E. B. (2013). Network structure and systemic risk in banking systems. *Handbook of Systemic Risk*, pages 327–368.

Duffie, D., Scheicher, M., and Vuillemey, G. (2015). Central clearing and collateral demand. *Journal of Financial Economics*, 116(2):237–256.

References II

Eisenberg, L. and Noe, T. (2001). Systemic risk in financial systems. *Management Science*, 47(2):236–249.

Freixas, X., Parigi, B. M., and Rochet, J.-C. (2000). Systemic risk, interbank relations, and liquidity provision by the central bank. *Journal of Money, Credit and Banking*, pages 611–638.

Gai, P., Haldane, A., and Kapadia, S. (2011). Complexity, concentration and contagion. *Journal of Monetary Economics*, 58(5):453–470.

Glasserman, P. and Young, H. P. (2015). How likely is contagion in financial networks? *Journal of Banking & Finance*, 50:383–399.

Peltonen, T. A., Scheicher, M., and Vuillemey, G. (2014). The network structure of the CDS market and its determinants. *Journal of Financial Stability*, 13:118–133.

Vuillemey, G. and Peltonen, T. A. (2015). Disentangling the bond–CDS nexus: A stress test model of the CDS market. *Economic Modelling*, 49:32–45.

Pricing Counterparty Exposures

Why is it important to mark positions?

- We can measure variation margin (VM) payments under stress precisely.
- The same exercise allows us to estimate initial margin buffers.

Apply the following steps:

1. Bootstrap credit curves to market spreads for all contracts.
2. Disaggregate all index positions to single-name equivalents. Retain single-name exposures; discard tranches.
3. Mark positions at inception, to baseline on the stress date, and to shock on the stress date.

Data

- Transaction- and position- level data provided by Depository Trust Clearing Corporation (DTCC). Features:
  - We collect data wherein either counterparty and/or position is US-domiciled.
- Content used for this paper:
  - Position-level counterparty exposures, aggregated to the firm level.
  - Transaction-level: notional amounts, recovery, reference entity, maturity.
  - Credit spread term structure from Markit.

Table: Summary Statistics

As-of-date	# Firms	# Positions	# Reference Entities
10/03/2014	959	6,389,129	3173

Marking to Market

1. Consider a CDS on a reference obligation.
   - λ^* is the market-implied default arrival rate that sets a CDS contract at fair value.
   - c is the coupon rate.
   - T is the maturity.
   - x sells $\$N$ protection to y.

   1. Premia c are paid quarterly from the buyer so long as the underlying does not default and are described by $V^x_{prem}(T, c, \lambda^*)$.
   2. Payments are paid from the seller upon default and are described by $V^y_{pay}(T, \lambda^*)$.

2. The NPV of the swap is:

$$NPV^{x \to y}(N, \lambda^*, c) = N \left[V^x_{prem}(T, c, \lambda^*) - V^y_{pay}(T, \lambda^*) \right] \tag{9}$$

where $\lambda^* \in \{\lambda^*_0, \lambda^*_n, \lambda^*_{shock}\}$.

Marking to Market

3. The MtM of the position is the difference between the NPV at t_n and NPV at t_0:

$$MtM^{x\to y}(N,\lambda_0^*,\lambda_n^*,c) = NPV^{x\to y}(N,\lambda_n^*,c) - NPV^{x\to y}(N,\lambda_0^*,c) \quad (10)$$

4. Analogously, the MtM under stress:

$$MtM^{x\to y}(N,\lambda_0^*,\lambda_{shock}^*,c) = NPV^{x\to y}(N,\lambda_{shock}^*,c) - NPV^{x\to y}(N,\lambda_0,c) \quad (11)$$

5. The difference in MtM, under shock relative to baseline, is the **variation margin** (VM) payment to be paid.
   - VM may be levied within a one-hour window (ICE CC).
   - Otherwise, calculated and paid daily per market convention.

$$VM^{x\to y} = MtM^{x\to y}(N,\lambda_0^*,\lambda_{shock}^*,c) - MtM^{x\to y}(N,\lambda_0^*,\lambda_n^*,c) \quad (12)$$

Bootstrapping Technique · 2015 CCAR Global Market Shock

Bootstrapping Credit Curves

1. The first stage is calculation of the initial hazard rate, h_1.

$$V_{premia}(h_1) = s_1 \sum_{i=1}^{N_1} F(t_i)\Delta_i \left(e^{-h_1 t_i} + \alpha \frac{e^{-h_1 t_i} - e^{-h_1 t_{i-1}}}{2} \right) \tag{13}$$

$$V_{pay}(h_1) = (1 - R) \sum_{i=1}^{N_1} F(t_i) \left[e^{-h_1 t_{i-1}} - e^{-h_1 t_i} \right] \tag{14}$$

$$h_1* = \underset{h_1}{\text{argmin}} \left[\left(V_{premia}(h_1) - V_{pay}(h_1) \right)^2 \right] \tag{15}$$

2. The second stage is to compute h_2*, given h_1*.

$$V_{premia}(h_2|h_1) = s_2 \left\{ C(h_1) - \sum_{i=N_1+1}^{N_2} F(t_i)\Delta_i \left[P(t_i) - P(t_{N_1}) - \alpha \frac{P(t_i) - P(t_{i-1})}{2} \right] \right\} \tag{16}$$

$$V_{pay}(h_2|h_1) = A(h_1) + \sum_{i=N_1+1}^{N_2} F(t_i)(P(t_i) - P(t_{i-1})) \tag{17}$$

where $P(t_i) = 1 - e^{-h_2 t_i} \; \forall \; i <= N_1$ and $P(t_i) = 1 - e^{-h_1 t_i}$ otherwise. $A(h_1)$ and $C(h_1)$ are known. h_2* is the solution over $(N_1, N_2]$ for

$$\underset{h_2}{\text{argmin}} \left[\left(V_{premia}(h_2|h_1) - V_{pay}(h_2|h_1) \right)^2 \right] \tag{18}$$

Bootstrapping Credit Curves (continued)

3. In this manner, we can compute a term structure of default intensities for each reference entity, over possible CDS payment dates:

$$\left\{(0, N_1] : h_1^*, (N_1, N_2] : h_2^*, (N_2, N_3] : h_3^*, ...(N_{n-1}, N_n] : h_n^*\right\} \tag{19}$$

or alternatively stated, over time increments:

$$\left\{(0, T_1] : h_1^*, (T_1, T_2] : h_2^*, (T_2, T_3] : h_3^*, ...(T_{n-1}, T_n] : h_n^*\right\} \tag{20}$$

Back

Initial Margin Estimation

We follow a standard value-at-risk metric for estimating initial margin (IM).

- Initial margin is described by contractual attributes a: (1) reference entity, (2) term, (3) coupon rate, (4) maturity, (5) currency, (6) documentation clause, (7) seniority tier

$$MtM_{\boldsymbol{a}}(N, \boldsymbol{\lambda^t}, \boldsymbol{\lambda^{t+10}}, c_a) = NPV_{\boldsymbol{a}}(N, \boldsymbol{\lambda^{t+10}}, c_a) - NPV_{\boldsymbol{a}}(N, \boldsymbol{\lambda^t}, c_a). \tag{21}$$

The replacement period change in value of the bilateral portfolio $\boldsymbol{A}$ between counterparties x and y at time t is:

$$MtM_{\boldsymbol{A}}^{x \to y}(t) = \sum_{a \in A} MtM_{\boldsymbol{a}}^{x \to y}(N, \boldsymbol{\lambda^t}, \boldsymbol{\lambda^{t+10}}, c_a). \tag{22}$$

Initial Margin Estimation

Finally, we compute the IM posted by x to y at t as the replacement period change in portfolio value not exceeded at 99% confidence, subject to IM conventions:

$$IM_{x:y}(t) = max(0, \mathbb{I}_{x:y} * \inf\{m \in \{MtM_{\boldsymbol{P}}^{x \to y}(t-1000), ..., MtM_{\boldsymbol{P}}^{x \to y}(t-1)\} : \mathbb{P}(L > m) \leq 0.5\%\}) \tag{23}$$

The total IM held by y is given as the sum of all IMs received from its counterparties:

$$IM_y(t) = \sum_{x \in X} IM_{x:y}(t). \tag{24}$$

Back

CCP Clearing

This expression assumes that the initial margin collected from CCP counterparties can be used to meet the firm's obligations. This additionally includes the guarantee fund, γ, of the CCP which will be used before the CCP starts reducing its payments.

$$s_0 = \left[\sum_{k \neq 0} \bar{p}_{0k} - \sum_{k \neq 0} \left((p_{k0} + c_{k0}^{IM}) \wedge \bar{p}_{k0} \right) - \gamma_0 \right]_+ ,$$

Back

Bootstrapping Credit Curves

Portfolio credit survival and default rates are central to pricing CDS contracts. We infer these rates from market information through a bootstrap technique.

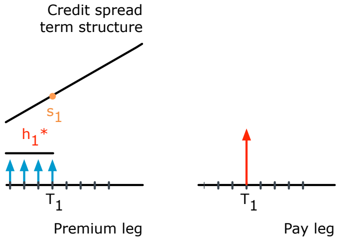
- Premia are received so long as a credit survives. CDS payments are made upon a credit's default.
- Bootstrap establishes *hazard rates* (h_i)– which, in turn, imply survival and default probabilities– through all tenors upon a valuation date.

Back

Bootstrapping Credit Curves

Portfolio credit survival and default rates are central to pricing CDS contracts. We infer these rates from market information through a bootstrap technique.

- Premia are received so long as a credit survives. CDS payments are made upon a credit's default.
- Bootstrap establishes *hazard rates* (h_i)– which, in turn, imply survival and default probabilities– through all tenors upon a valuation date.



Bootstrap through T_1

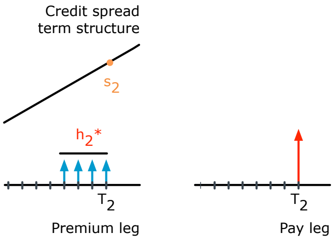
Back

Bootstrapping Credit Curves

Portfolio credit survival and default rates are central to pricing CDS contracts. We infer these rates from market information through a bootstrap technique.

- Premia are received so long as a credit survives. CDS payments are made upon a credit's default.

- Bootstrap establishes *hazard rates* (h_i)– which, in turn, imply survival and default probabilities– through all tenors upon a valuation date.



Bootstrap through T_2

Back

Bootstrapping Credit Curves

Portfolio credit survival and default rates are central to pricing CDS contracts. We infer these rates from market information through a bootstrap technique.

- Premia are received so long as a credit survives. CDS payments are made upon a credit's default.

- Bootstrap establishes *hazard rates* (h_i)– which, in turn, imply survival and default probabilities– through all tenors upon a valuation date.

$$V_{prem} = s\mathbb{E}\left[\sum_{i=1}^{N} exp\left(-\int_0^{t_i} r_s ds\right)\mathbb{I}_{\tau > t_i}\right] \tag{25}$$

$$V_{pay} = \mathbb{E}\left[exp\left(-\int_0^{\tau} r_s ds\right)\mathbb{I}_{\tau \leq T}(1-R)\right] \tag{26}$$

- Using $\mathbb{E}\left[\mathbb{I}_{\tau < T_{N_i}}\right] = 1 - e^{-\int_0^{T_{N_i}} h_i(v)dv}$, we bootstrap credit curve over all traded tenors $T_{N_1}, T_{N_2}, T_{N_3}$ to generate a schedule $\left\{(0, T_1] : h_1^*, (T_1, T_2] : h_2^*, (T_2, T_3] : h_3^*, ...(T_{n-1}, T_n] : h_n^*\right\}$.

Back

2015 CCAR Global Market Shock

Corporate Credit							
Advanced Economies							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Spread Widening (%)	130.0	133.0	110.2	201.7	269.0	265.1	265.1
Emerging Markets							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Spread Widening (%)	191.6	217.2	242.8	277.5	401.9	436.4	465.8

Loan							
Advanced Economies							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Relative MV Shock (%)	-6.2	-6.7	-13.4	-22.6	-26.9	-30.5	-39.8
Emerging Markets							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Relative MV Shock (%)	-23.2	-27.6	-32.0	-36.4	-61.3	-66.7	-72.2

State & Municipal Credit							
	AAA	AA	A	BBB	BB	B	<B or Not Rated
Spread Widening (bps)	12	17	37	158	236	315	393

Back