The Economics of Collateral

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Outline

- “Collateral scarcity”
- The market for collateral is segmented
- Collateral management and collateral transformation
- Literature
- Model of collateral with market segmentation
- Implications for policy

Hunger for collateral

- The crisis exposed risk in counterparties that were previously top credit rated
  - Banks
  - Sovereigns
- Response was to require security in lending (encumbering assets)
  - Growth of covered bond market (e.g., Spain)
  - Official asset purchases
- Regulatory reform led by G20 is increasing demands for high quality assets on many fronts:
  - Revised regulatory capital charges (Basel 2.5, 3)
  - Liquidity regulations (LCR, NSFR)
  - Move toward centralized clearing for derivatives (Dodd-Frank, EMIR)
    - Push toward trading on standardized platforms/exchanges
    - Central clearing of OTC
  - Call for initial margins of bilaterally cleared OTC derivatives
  - Imposing limits on collateral reuse

Collateral scarcity?

- Hard to argue that the global supply of collateral insufficient to meet increasing demands because:
  - Fiscal deficits of major, stable sovereigns
  - Cash is collateral
- But the price of collateral (opportunity cost of encumbering assets) may be rising.
- Estimates of collateral demand and supply
  - Wide range of estimates with no common methodology or data set
  - But increases in demand are likely outstripping increases in supply.
  - Boundaries of the “market for collateral” are unclear

The market for collateral is fragmented.

- What is collateral?
  - The best collateral is an asset that is liquid and whose future value is highly predictable (cash, T-bills)
  - But many assets taken as collateral are "safe" only relative to the risk they are meant to secure.
- Much collateral is "information sensitive"
  - The acceptability of collateral depends on the collateral takers' ability to assess its risks.
  - Different collateral takers have different information sets.
- Also different collateral takers evaluate an asset differently depending upon their own portfolio and their access to the market where the asset is traded.
- There are different market segments and there can be gains to trade from circulating collateral.
  - *Example:* Euro denominated, Spanish covered bond may be accepted by a big global bank but heavily haircut by a large US regional bank

Collateral management and collateral transformation-*outline*

- Purpose of collateral management
- How does collateral circulate?
  - Repo
  - Securities lending
  - Asset swaps and other
- Comparing banks and CCP's
- Collateral velocity
- Tri-party repo
  - US versus Europe

Purpose of collateral management

- Two ways to reduce collateral related costs:
  - Reduce the amount of collateral required

    expected loss given default = expected value of collateral

    - Eg. Portfolio margining
  - Reduce the unit cost

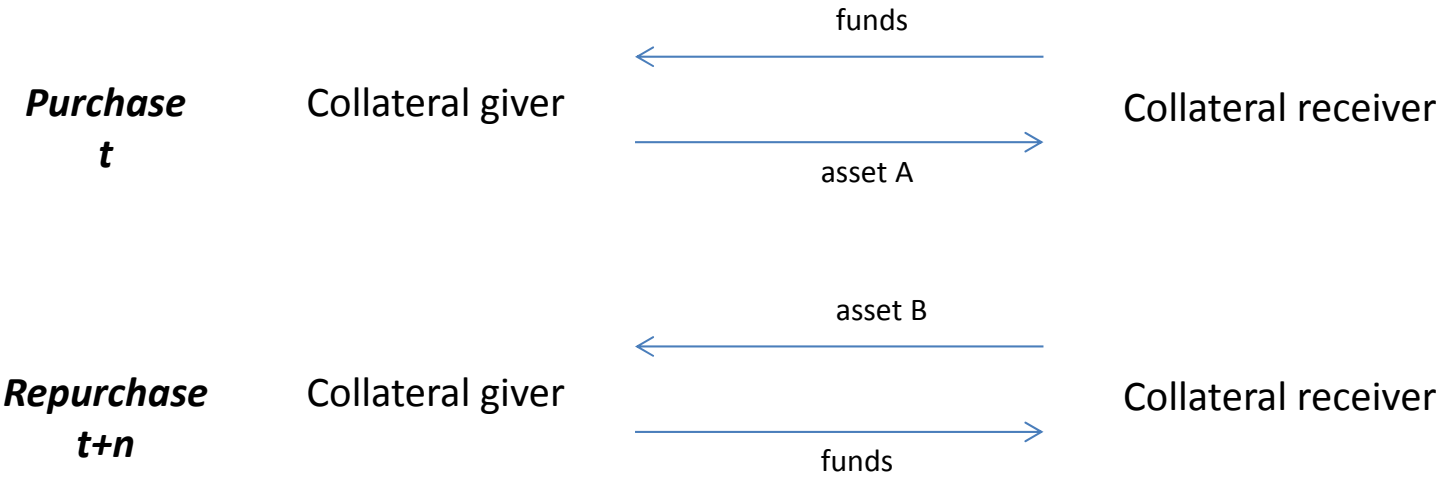
    collateral unit cost = unencumbered asset return – return on posted collateral

    - Eg. Allow collateral reuse

Collateral transformation

- Why?
  - Obtained required asset when you don't hold it currently
  - Give cheapest collateral that will be acceptable
- How?
  - Repo
  - Security lending
  - Other (asset swaps…)

Repo



- Repo is a means of
  - Funding
  - Asset transformation
- Purchase leg is a true sale. Collateral receiver can reuse as he wishes (compare to rehypothecation of a pledged asset)
- Repo term can vary from short term (e.g. overnight) to long term (>1 year)
  - S.t. gives collateral giver wide scope for collateral transformation
  - L.t. gives collateral receiver wide scope for collateral transformation

Securities lending

- Banks and other market participants can obtain temporary use of an asset by borrowing it (e.g., from a custodial agent such as State Street)
- Securities lending is active for
  - Equities
  - Fixed income
  - Academic research has largely focussed on equity (e.g., short-sales restrictions and market for corporate control)
  - Role in credit provision and funding understudied
    - (but see Krishnamurthy, Nagel & Orlov and Adrian, Begalle, Copeland & Martin).

Collateral management: banks

- Collateral is only one way of managing counterparty risks
- For OTC derivatives terms are set out in the credit support annex (CSA) of the ISDA master agreement
  - One CSA covers a wide range of products/risks (netting benefits)
  - Flexible: can be adapted depending upon the relationship
  - May or may not include initial margin
  - Sets out terms of marking to market (or model)…frequency, reference, currencies, variation margin timing
  - Sets out list of acceptable collateral
  - "160,000 CSAs of which 30-35% active"…information not public
- Large global banks active in all phases of collateral transformation/management
  - Repo, custody, prime brokerage, SL, global markets,…

Collateral management: CCPs

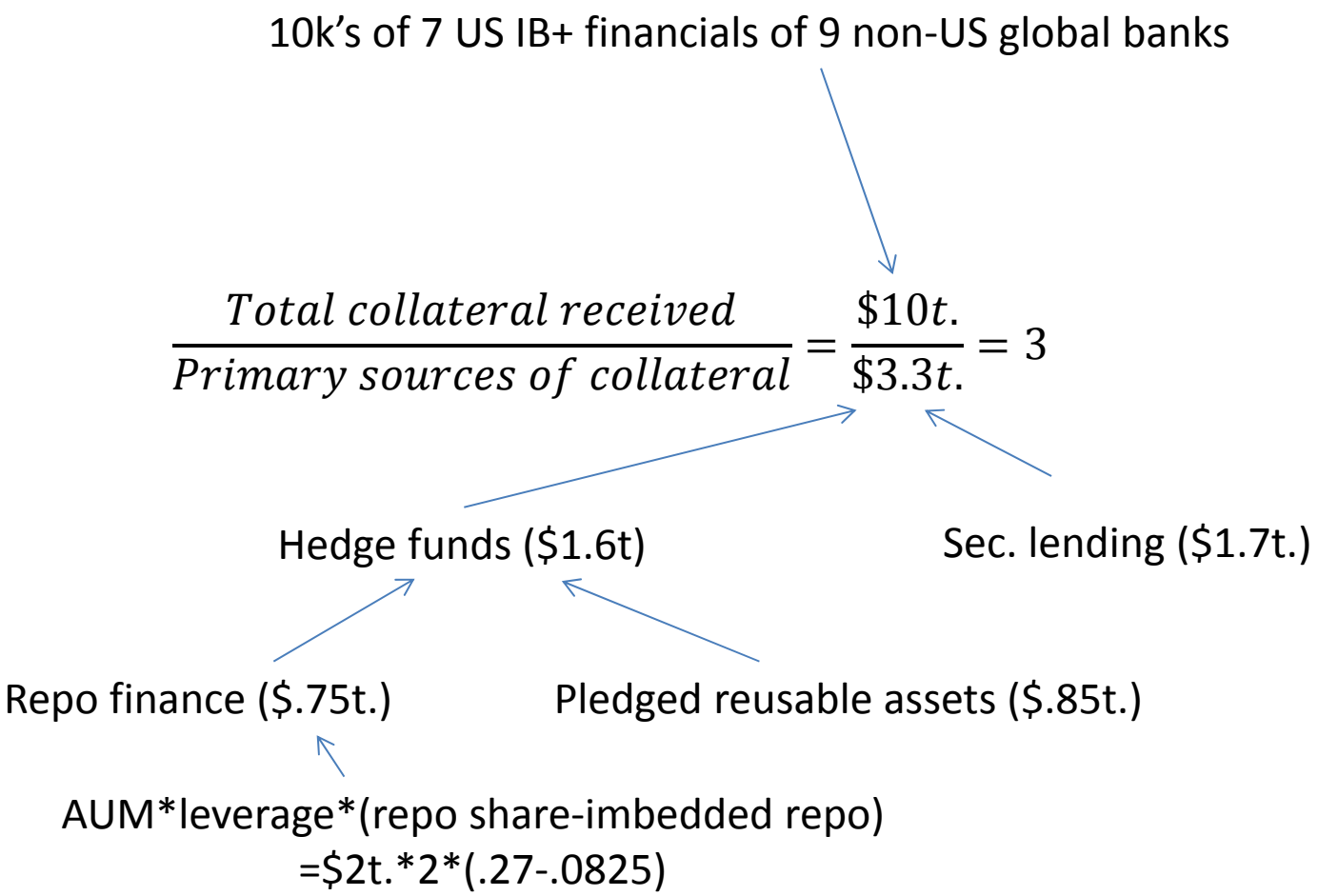
- Counter-parties are clearing members (not clients or non-clearing banks)
  - Highly concentrated…bilaterally
  - Very little information of clearing members' counter-parties
- Tools: (1) initial margins (IM), (2) default fund (DF)
- Mark to market daily and possibly more frequently (e.g. as managed by CRO of CCP)
- Typically narrow list of acceptable collateral (cash, T-bills…)
- Typically product/currency specialized…(but changing with CCP growth)
- Typically limited scope for portfolio margining (e.g., offsets in SPAN model)…but developments underway.

Initial margins: banks *versus* CCP's

- IM of a CCP is not directly comparable to IM in the CSA of a bank because:
  - Not all CSAs call for IM
  - Different counter-parties
  - CCP has DF as well as IM
  - Higher IM in a CSA may compensate for less frequent variation margin calls or wider range of acceptable collateral (haircut)

Velocity of collateral

- A measure of how freely collateral circulates
  - higher velocity=more elastic supply
- Singh's calculation
- Robustness, validation, and history limited by data limitations.
- Affected by
  - Appetite for risk
  - Contractual and regulatory limits on collateral reuse
  - Other market frictions (see Tri-party repo reforms)


10k's of 7 US IB+ financials of 9 non-US global banks
$\frac{Total\ collateral\ received}{Primary\ sources\ of\ collateral} = \frac{\$10t.}{\$3.3t.} = 3$
Hedge funds ($1.6t)
Sec. lending ($1.7t.)
Repo finance ($.75t.)
Pledged reusable assets ($.85t.)
AUM*leverage*(repo share-imbedded repo)
=$2t.*2*(.27-.0825)

Operational requirements in repo

- Each transaction involves 4 settlement risks
  - Cash settlement and securities settlement in the purchase leg
  - Cash settlement and securities settlement in the repurchase leg
- In bilateral repo both may require that both counterparties are members of the CSD and have accounts at CB
- Also need valuation, collateral management and (for term repo) variation margining
- Tri-party repo simplifies the process by giving these operational tasks to tri-party repo agents
- Tri-party repo agent is not a trading platform but an agent for post-trade activities

Tri-party repo market: US

- Most liquid segment of repo trading…
  - a subset of the General Collateral (GC) repo
  - perhaps 50% of total repo in US (Gorton&Metrick)
- 2 tri-party repo agents (JPM Chase and BNY Mellon)
- Mostly very short term (overnight)
- Collateral transformation daily (as well repo rate, haircut…)
  - Removes need for variation margining
- Tri-party agent enters as principal intra-day between close of repurchase leg and opening of new purchase leg
- Systemic risk: major concern of regulators…Solution? Tighten operating standards (as in Europe)?

Tri-party repo market: Europe

- Agents: Clearstream Luxembourg, Euroclear, BNY Mellon, JPM, and SIS
- Smaller fraction (about 10%) of total European repo market (European repo survey)
- More longer-term repo than US including term repos (>1 year)
  - Repo agents manage collateral transformation (substitution) and variation margins
- Agents do not enter as principals in the contract (contrast with US)
- Important friction in operating with many national CSD's and central banks
  - Circulation of collateral has been impeded by "repatriation requirement"…recently removed. T2S (2015?) may increase velocity.

Structural modelling of derivatives reform

- Duffie and Zhu (2011) emphasize trade-off multi-product versus multi-agent netting (work horse model in field)
- Cont and Kokholm (2012) show correlation across product classes tends to increase relative attractiveness of CCP even if product specialized.
- Heller and Vause (2012), Sidanius and Zikes (2012) more detailed calibration of effect of CCP's for IRSwaps and CDS. Highlight jump risk in CDS in stressed scenarios.
- Heath, Kelly and Manning (2013) distinguish core versus periphery…single CCP may benefit core but not periphery.
- Duffie, Scheicher and Vuillemey (2014) more detailed calibration of IRS and CDS clearing. Point out major impact of reform on collateral demand is introduction of IM. Central clearing 2nd order.
- Anderson, Dion and Saiz (2013) introduce the two country set up and take into account also the risk concentration in CCP's.

Our approach: collateral demand in a segmented market

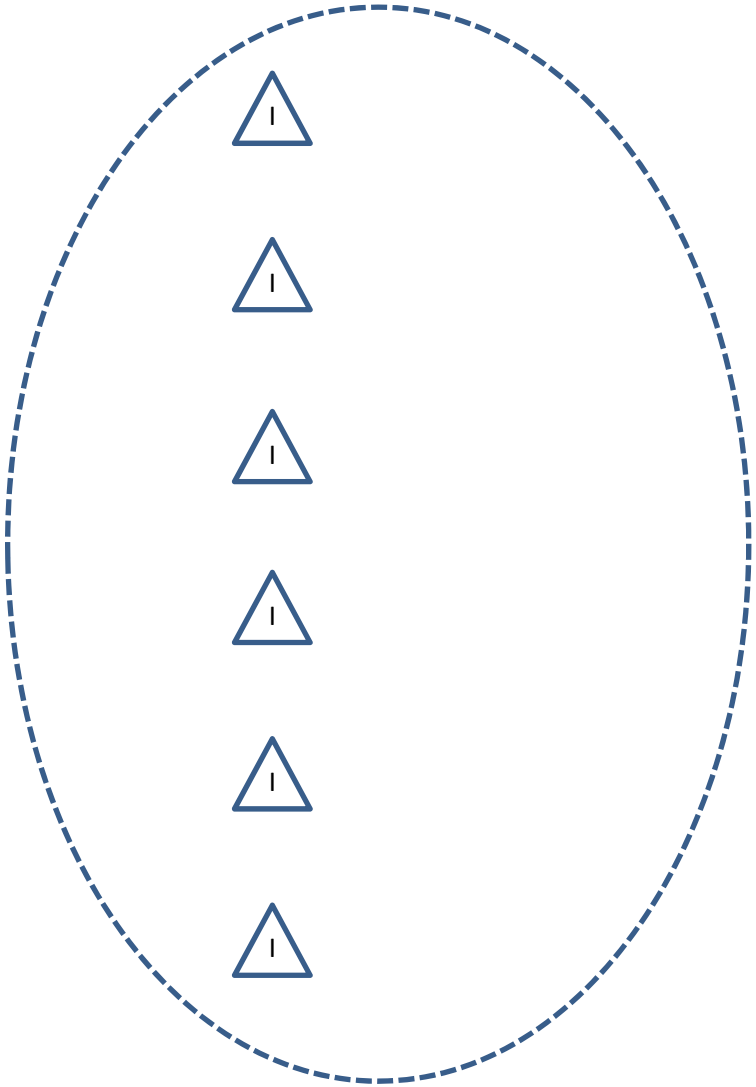
- Regional structure.
  - Acceptable collateral differs across regions…currency, time zone, issuer type (real estate, commodities…)
- Investors take long and short positions, trade with regional banks and post 1-sided IM in “local collateral”
- Banks don’t take proprietary positions but just lay off risk.
- Banks trade intra-regionally and post 2 sided IM in “local” collateral
- Banks may trade inter-regionally and post 2 sided IM in “global” collateral
- Local collateral can be transformed in global collateral with a haircut

Plan of analysis

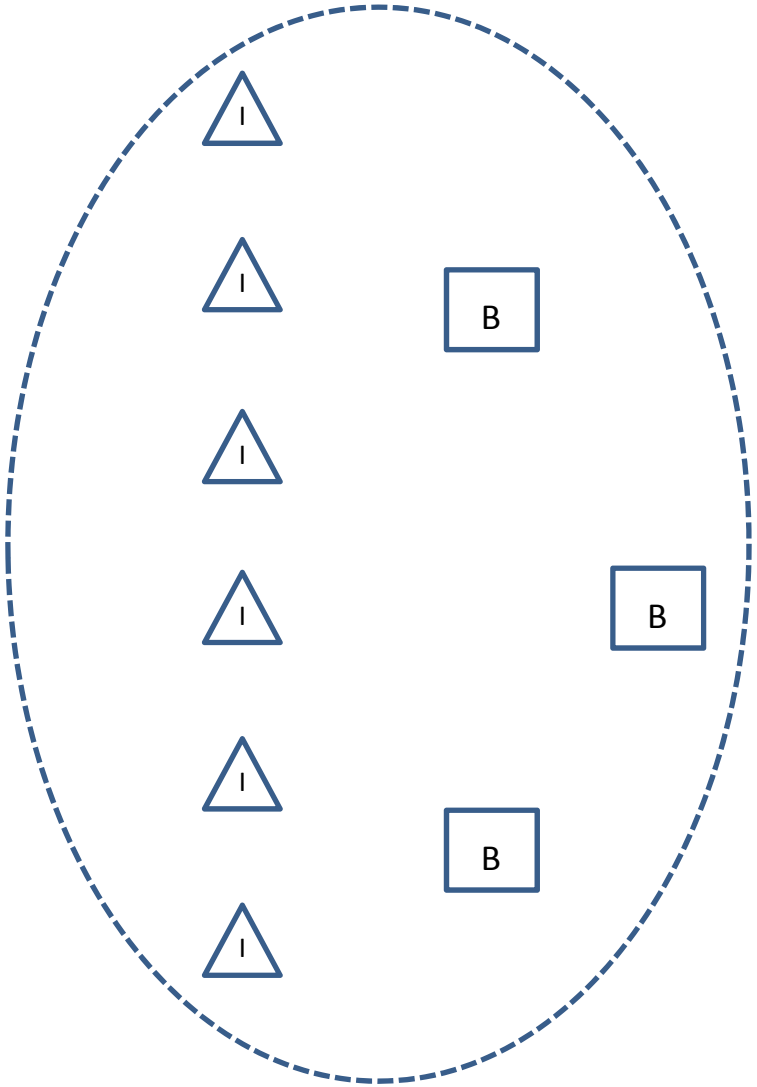
- Collateral demand for initial margins in a single derivative market
  - Benchmark: OTC market with bilateral clearing
  - Centralized clearing
  - Global banks
- Variation margins, margin call frequency, liquidity and operational risk
  - One product
  - Multi-product
    - Integrated
    - Segmented

Benchmark model: Bilateral trading of one OTC Derivative

- I investors trade with B banks in each of R regions



Region 1



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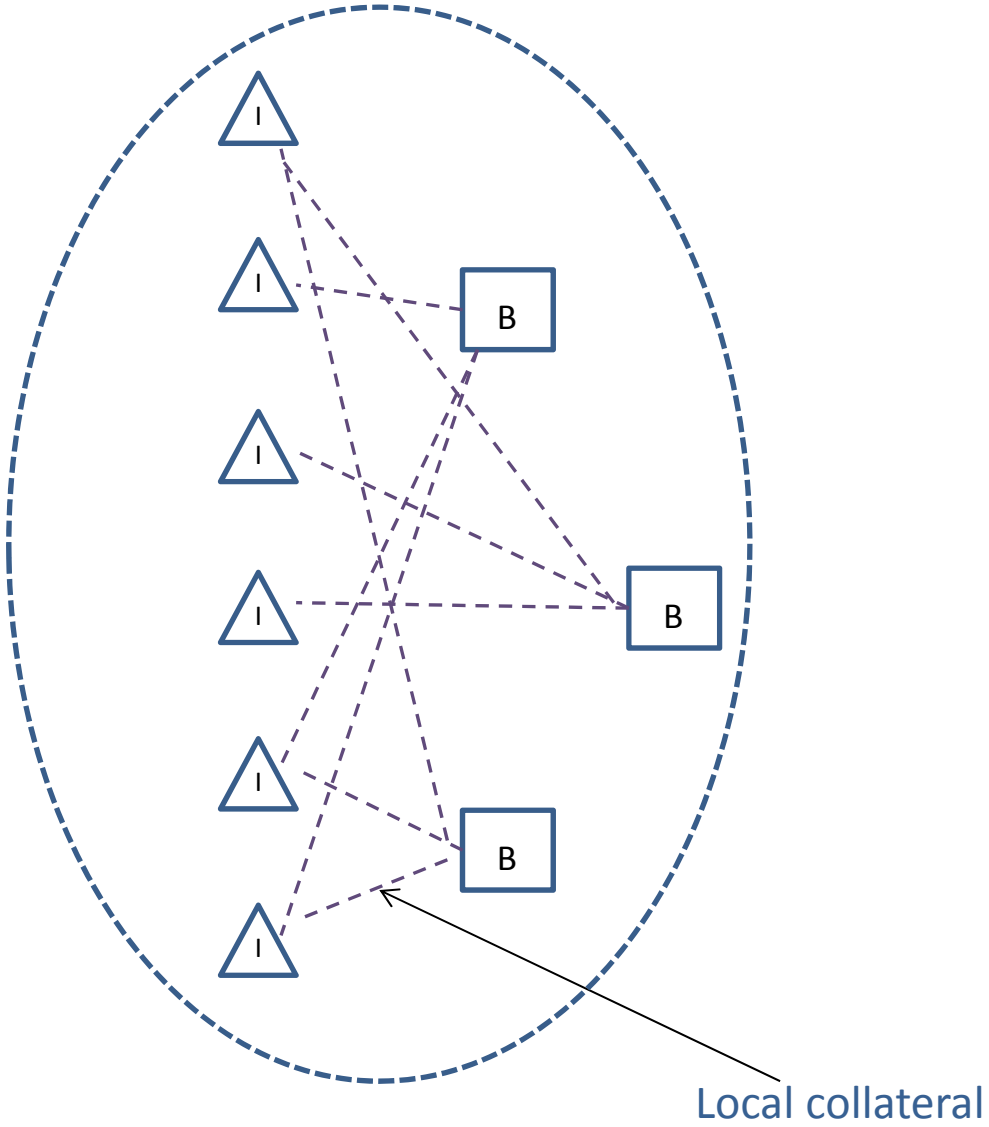
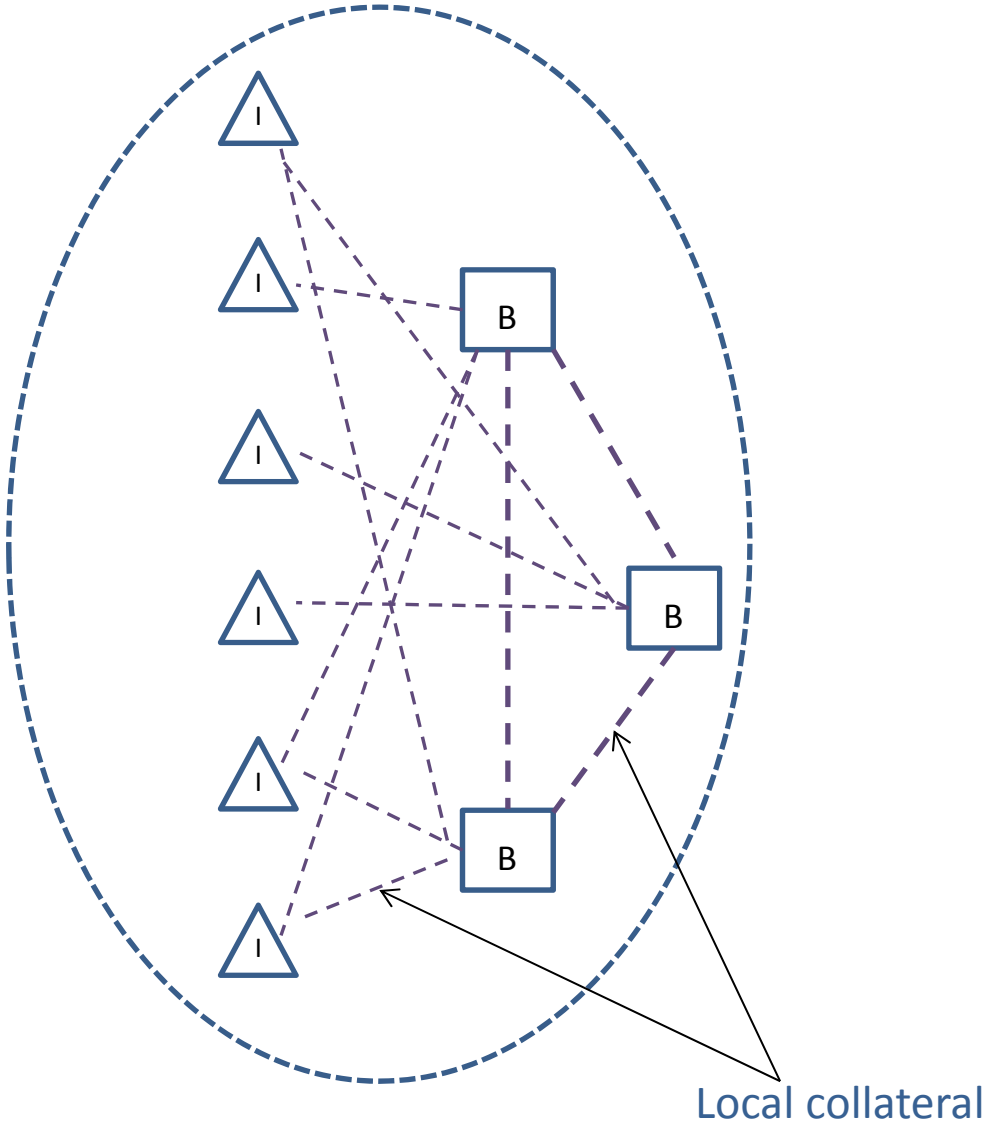
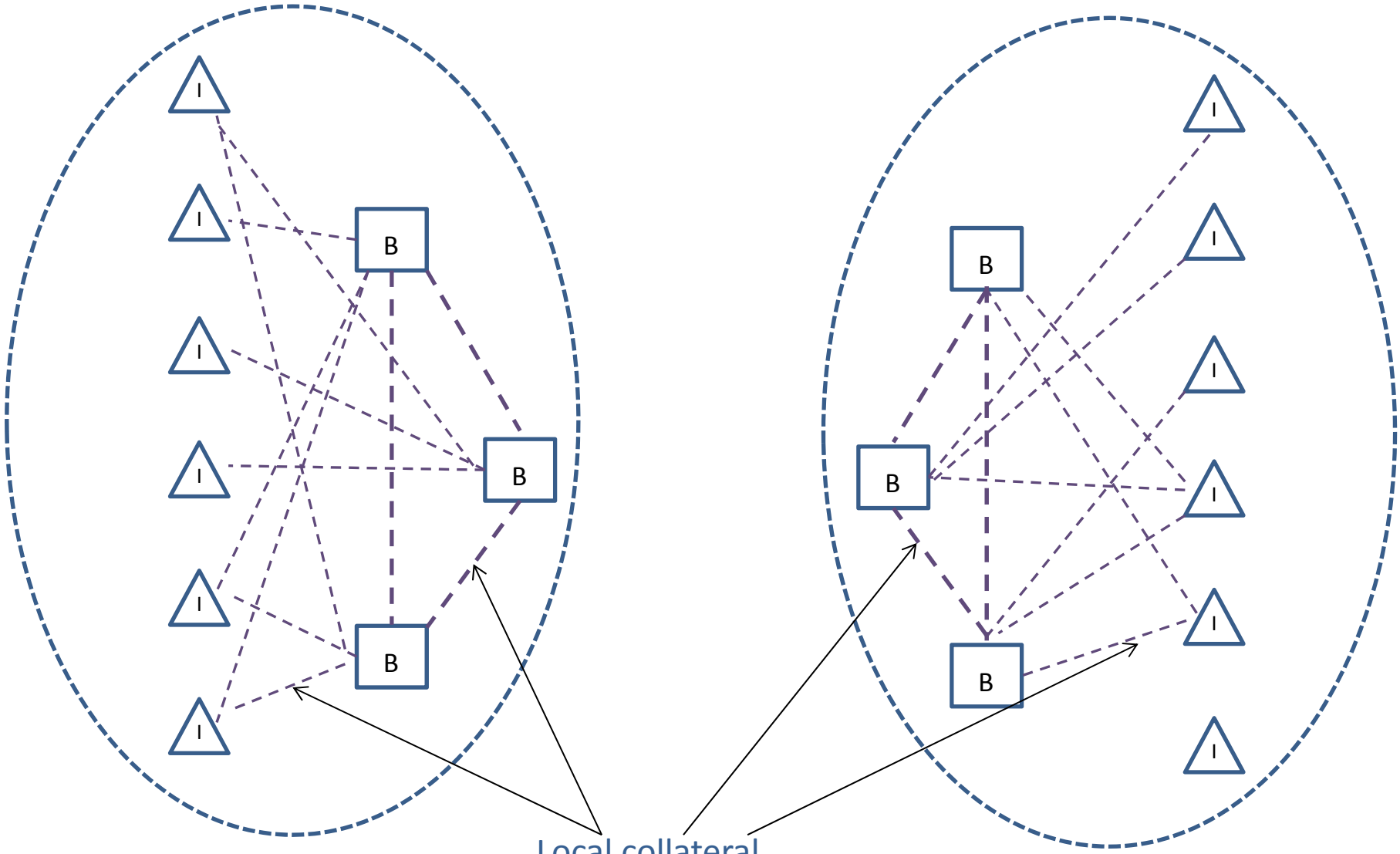


Region 1



Region 1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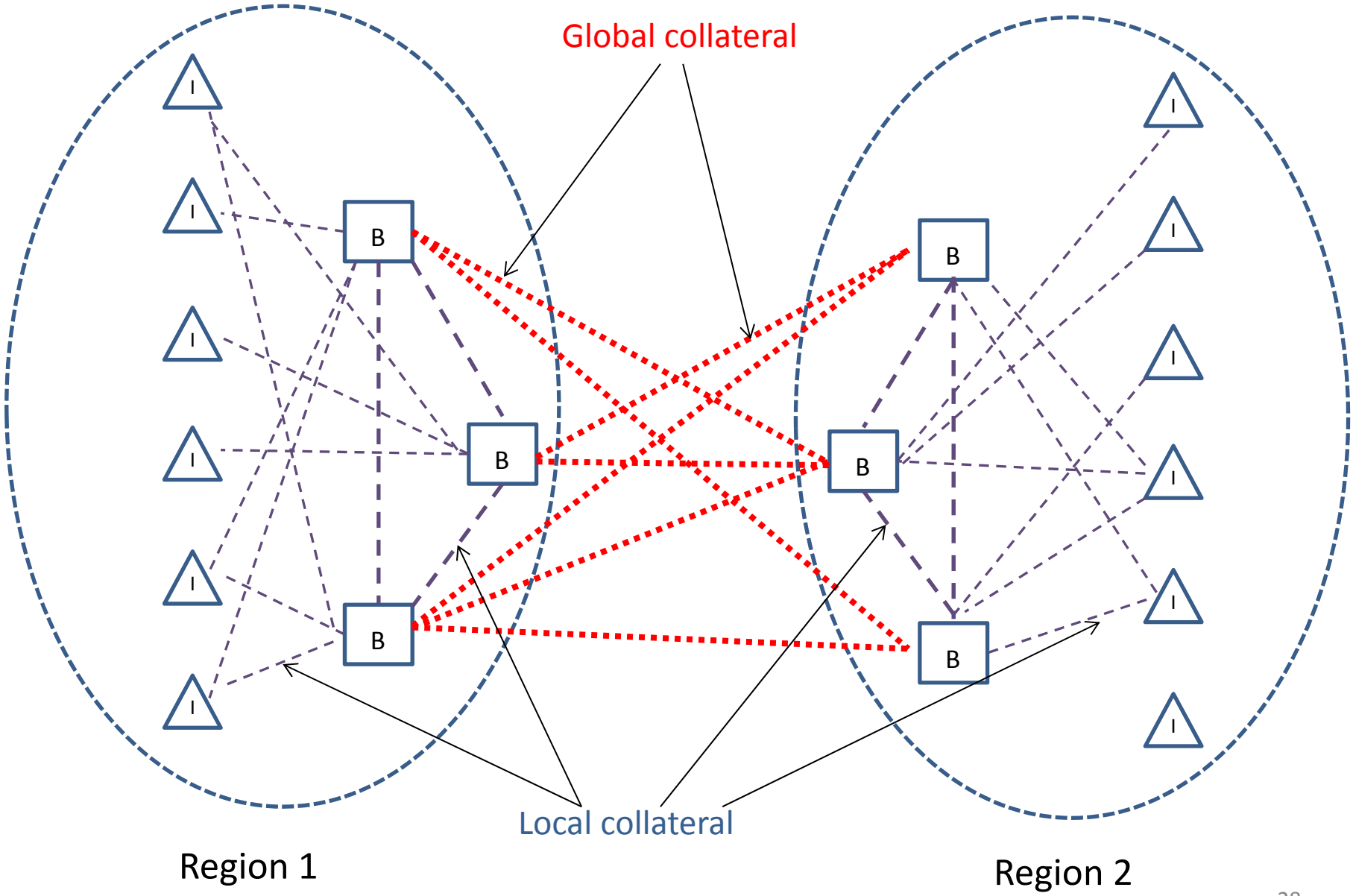
Local collateral
Region 1
Region 2

Bilateral Trading



Investors' / banks' positions

- Investor positions are denoted: $W^r{}_{ib}$

  draws from normal distribution $N(0,\sigma^2{}_W)$

- Bank positions are denoted: $W^r{}_{bi} = -W^r{}_{ib}$

- Aggregate notional value: $\sum_{r=1}^{R}\sum_{i=1}^{I}\sum_{b=1}^{B} / W^r{}_{ib} /$
- Notional value $/ W^r{}_{ib} /$ is a draw from half normal distribution with mean $\sigma^2{}_W(2/\pi)^{1/2}$
- Normalize $\sigma^2{}_W$ to set aggregate position size to 1 for all I, B, R

Investors' collateral

- Derviative return: z ~ N(0,$\sigma^2{}_z$)
- Bank *b* exposure against counterpart *i*: $X^r{}_{ib} = \varepsilon \, \mathrm{Max}(W^r{}_{ib}\, z, 0)$
- Total bank *b* exposure: $X^r{}_b = \sum_{i=1}^{I} X^r{}_{ib}$
- Initial margins set to cover 99% of possible losses.
- Investor *i* collateral posted to bank *b*:

$$C^r{}_{ib} = 2.33 |W^r{}_{ib}| \sigma_z$$

Banks' regional collateral

- Banks can net the trades in inter-bank market.
- Net position of bank *b*: $Y^r{}_b = \sum_{i=1}^{I} W^r{}_{ib}$
- Netting trades between bank *b* and *b'*: $y^r{}_{bb'}$
- Bank *b* position after regional netting:

  $$Y^{r*}{}_b = Y^r{}_b + \sum_{b'} y^r{}_{bb'}$$
- Collateral posed by bank *b* in regional netting:

  $$C^r{}_b = 2.33\ \sigma_z \sum_{b'} |y^r{}_{bb'}|$$

Banks' inter-regional collateral

- Netting trades between bank *b* and *b'* (if *b'* is from other region): ${y^{rr'}}_{bb'}$
- Bank *b* position after inter-regional netting:
  $${Y^{r**}}_{b} = {Y^{r*}}_{b} + \sum_{r'} \sum_{b'} {y^{rr'}}_{bb'}$$
- Regional collateral faces 'haircut' in inter-regional trades. Difference between regional collateral and inter-regional collateral is $u \sim N(0,{\sigma^2}_{u})$
- Collateral posed by bank *b* in inter-regional netting:
  $${C^{r*}}_{b} = 2.33(\sigma_z + \sigma_u) \sum_{r'} \sum_{b'} | {y^{rr'}}_{bb'} |$$

Simulation

- Question: how do exposures and collateral demand vary with I, B, and R
  - 3 dimensions of market depth
- In simulation we set $\sigma_z = 0.1$ and $\sigma_u = 0.05$
  - Later argue that implied haircut is reasonable. Reflects required increased liquidity cushion to face normal marking to market.

Total exposures

- Table 4: Total bank exposures after global netting, 2 Regions

Investors	Number of Banks					
0	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000
4.0000	0.0095	0.0082	0.0074	0.0067	0.0062	0.0058
6.0000	0.0077	0.0067	0.0060	0.0055	0.0051	0.0048
8.0000	0.0067	0.0058	0.0052	0.0048	0.0044	0.0041
10.0000	0.0060	0.0052	0.0047	0.0042	0.0039	0.0037
12.0000	0.0055	0.0048	0.0042	0.0039	0.0036	0.0034
14.0000	0.0051	0.0044	0.0039	0.0036	0.0033	0.0031

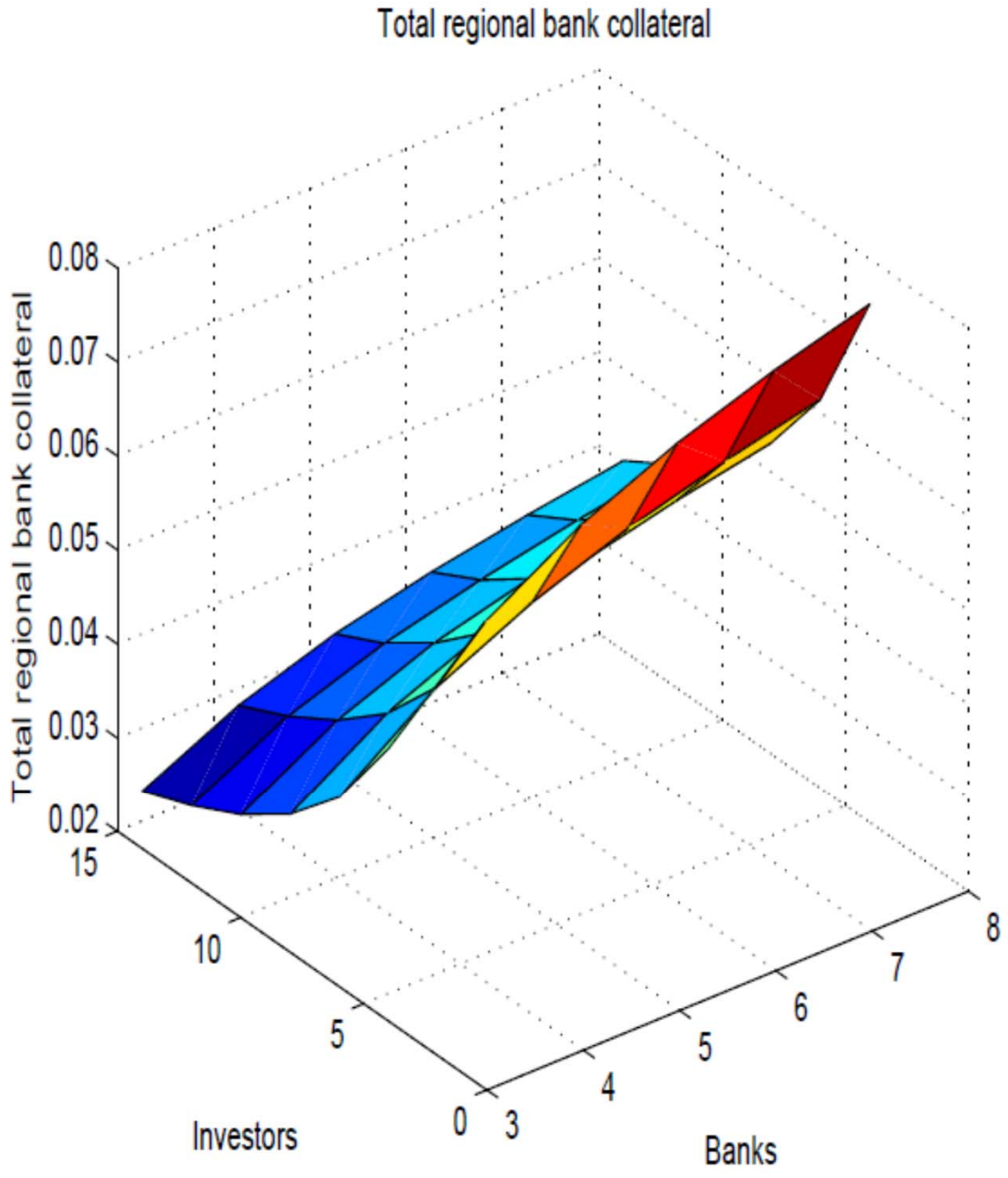
Total bank exposures decrease when number of banks goes up and number of investors goes up. **Deeper the market lesser the exposure.**

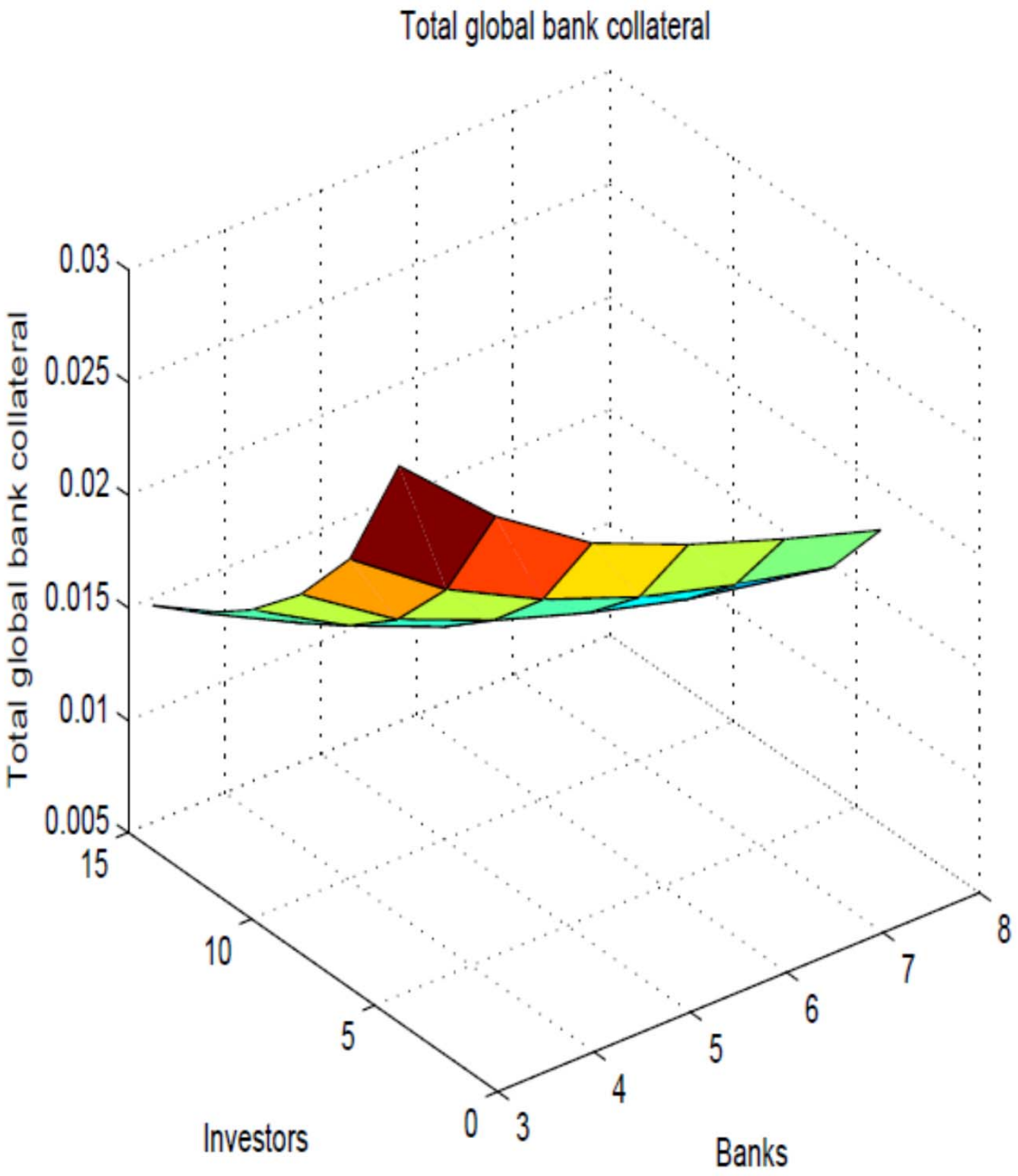
Collateral demand

Table 5: Total collateral demand, 2 Regions

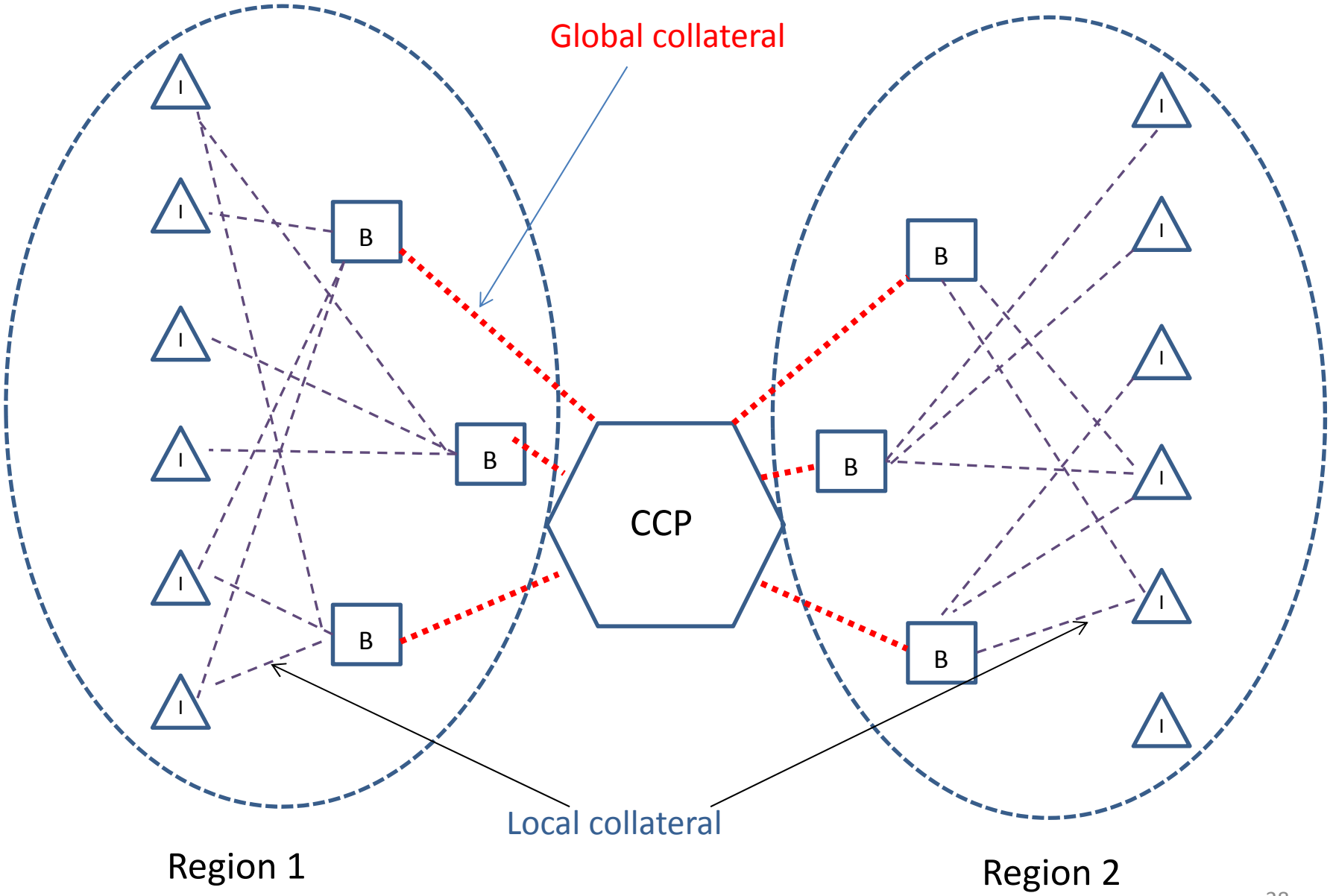
Investors	Number of Banks					
0	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000
4.0000	0.3117	0.3170	0.3202	0.3228	0.3247	0.3262
6.0000	0.2972	0.3015	0.3041	0.3062	0.3079	0.3092
8.0000	0.2886	0.2922	0.2948	0.2965	0.2978	0.2990
10.0000	0.2826	0.2861	0.2883	0.2898	0.2911	0.2921
12.0000	0.2783	0.2814	0.2835	0.2847	0.2858	0.2869
14.0000	0.2750	0.2777	0.2797	0.2809	0.2820	0.2829

Total bank collateral increase when number of banks goes up and decreases when number of investors goes up.


Total regional bank collateral
Total regional bank collateral
0.08
0.07
0.06
0.05
0.04
0.03
0.02
15
10
5
0
Investors
3
4
5
6
7
8
Banks


Total global bank collateral
Total global bank collateral
0.03
0.025
0.02
0.015
0.01
0.005
15
10
5
0
Investors
3
4
5
6
7
8
Banks

Centralized Clearing Among Banks



Centralized clearing among banks

- Central clearing of all inter-bank trades ➔ all interbank trades involve posting an 'haircut'
- Total collateral posed by bank b: $C^r{}_b = 2.33(\sigma_z + \sigma_u) \sum_r \sum_{b'} | y^r{}_{bb'} |$

Table 5: Total collateral demand, 2 Regions

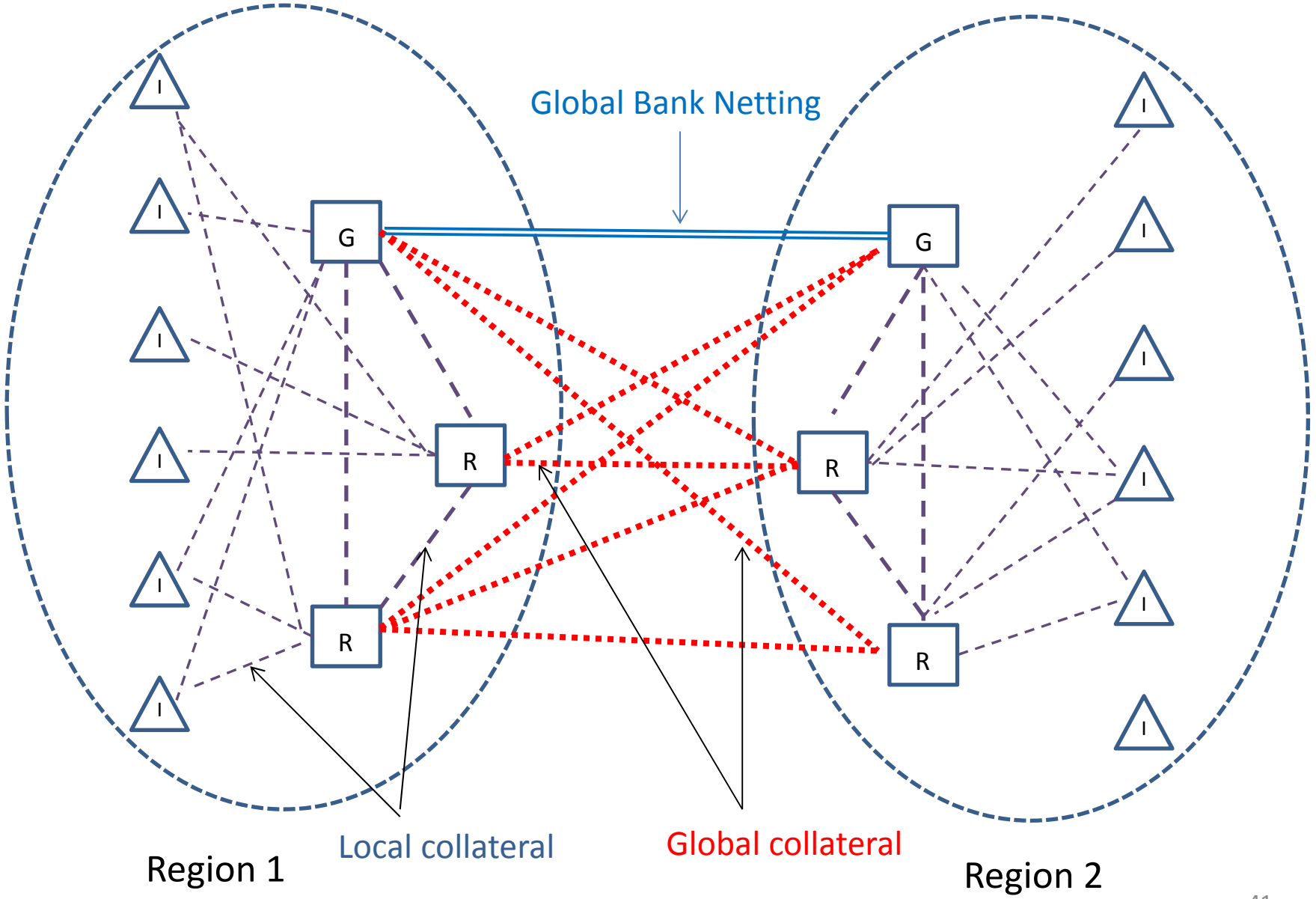
Investors	Number of Banks					
0	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000
4.0000	0.3117	0.3170	0.3202	0.3228	0.3247	0.3262
6.0000	0.2972	0.3015	0.3041	0.3062	0.3079	0.3092
8.0000	0.2886	0.2922	0.2948	0.2965	0.2978	0.2990
10.0000	0.2826	0.2861	0.2883	0.2898	0.2911	0.2921
12.0000	0.2783	0.2814	0.2835	0.2847	0.2858	0.2869
14.0000	0.2750	0.2777	0.2797	0.2809	0.2820	0.2829

Table 6: Total collateral with centralized clearing of all bank trades, 2 Regions

Investors	Number of Banks					
0	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000
4.0000	0.3362	0.3461	0.3524	0.3572	0.3615	0.3638
6.0000	0.3173	0.3253	0.3304	0.3343	0.3449	0.3399
8.0000	0.3060	0.3127	0.3175	0.3208	0.3338	0.3256
10.0000	0.2981	0.3045	0.3087	0.3116	0.3141	0.3158
12.0000	0.2924	0.2982	0.3021	0.3045	0.3068	0.3086
14.0000	0.2881	0.2933	0.2970	0.2993	0.3015	0.3030

In the case of centralized clearing the total collateral demand goes up. That's especially pronounced when there are many banks and few investors.

The case of Global Banks



The case of global banks

- Global bank nets the trades on a group level first and then enters to trades with other banks.
- Two effects
  - Decreases global banks net position that needs to be hedge and decreases its collateral needs.
  - Decreases its ability to offset risk of other banks.

Table 10: Total collateral demand, 4 regions

Investors	Number of Banks					
0	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000
4.0000	0.3326	0.3348	0.3365	0.3375	0.3384	0.3392
6.0000	0.3142	0.3163	0.3176	0.3183	0.3190	0.3197
8.0000	0.3033	0.3051	0.3062	0.3069	0.3075	0.3081
10.0000	0.2961	0.2975	0.2985	0.2991	0.2997	0.3002
12.0000	0.2904	0.2919	0.2927	0.2934	0.2939	0.2944
14.0000	0.2861	0.2874	0.2883	0.2889	0.2894	0.2898

Table 11: Total collateral with centralized clearing of all bank trades, 4 Regions

Investors	Number of Banks					
0	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000
4.0000	0.3572	0.3639	0.3686	0.3719	0.3745	0.3768
6.0000	0.3343	0.3401	0.3438	0.3464	0.3485	0.3504
8.0000	0.3207	0.3257	0.3290	0.3313	0.3331	0.3347
10.0000	0.3116	0.3160	0.3188	0.3209	0.3226	0.3240
12.0000	0.3046	0.3087	0.3113	0.3132	0.3148	0.3161
14.0000	0.2992	0.3030	0.3055	0.3074	0.3088	0.3100

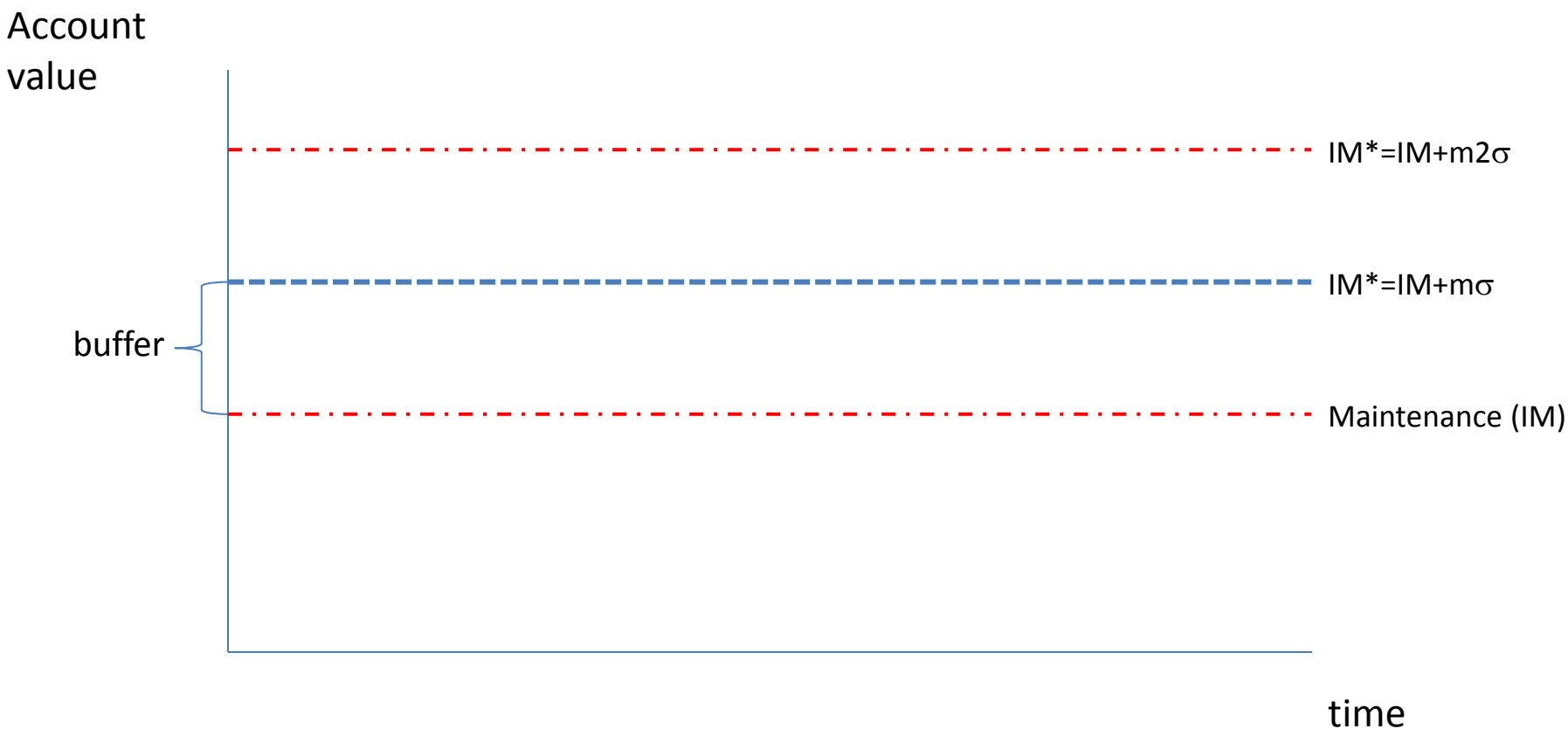
Table 12: Total collateral demand with one global bank, 4 regions

Investors	Number of Banks					
0	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000
4.0000	0.3086	0.3174	0.3226	0.3263	0.3289	0.3309
6.0000	0.2947	0.3020	0.3064	0.3092	0.3111	0.3129
8.0000	0.2864	0.2927	0.2965	0.2989	0.3009	0.3023
10.0000	0.2809	0.2865	0.2899	0.2919	0.2937	0.2950
12.0000	0.2767	0.2818	0.2848	0.2868	0.2884	0.2896
14.0000	0.2732	0.2782	0.2810	0.2830	0.2844	0.2855

The presence of global banks decreases the total collateral demand.

Variation margin, demand for liquidity, and operational risk

- Marking to market places demands on the participant's liquidity management.
- Often manage this by including a collateral buffer above a maintenance level.
- Fluctuations of account value trigger margin movements only after breaching thresholds.
- Simulation
  - Buffer = m σ_z
  - Simulate N days
  - Count M margin calls
  - N/M average days between margin calls
  - M/N average margin calls per day


Account value
IM*=IM+m2σ
IM*=IM+mσ
buffer
Maintenance (IM)
time

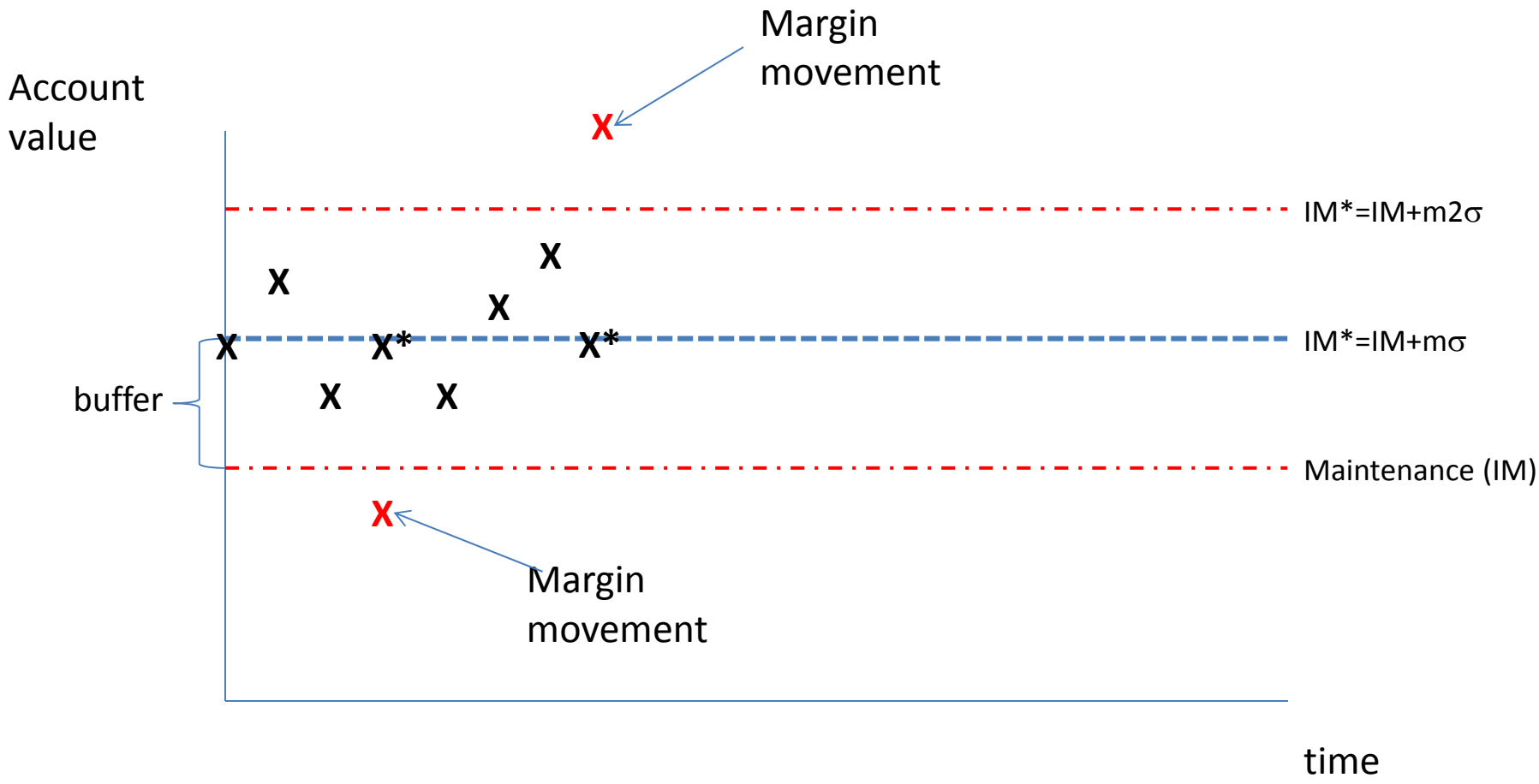

Account value
Margin movement
IM*=IM+m2σ
IM*=IM+mσ
buffer
Maintenance (IM)
Margin movement
time

Table 3: Maintenance margin and margin calls

Maintenance margin (multiples of σ)	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25
Margin call frequency in one market (days)	1.67	2.23	2.79	3.74	4.80	5.37	6.89	8.40
Margin call frequency in 4 segmented markets(days)	0.40	0.53	0.70	0.92	1.16	1.37	1.71	2.00
Margin call frequency in 4 integrated markets (days)	2.61	4.42	6.62	9.17	13.51	15.87	18.51	27.77
Margin call frequency in 8 segmented markets(days)	0.20	0.26	0.34	0.45	0.56	0.71	0.85	1.02
Margin call frequency in 8 integrated markets (days)	4.40	7.29	12.34	16.66	21.27	27.77	38.46	47.61

Discussion

- Doubling buffer from 0.5 m σ_z to m σ_z increases days between margin calls from 1.67 to 2.79.
- Interpretation of local collateral haircut of (σ_u / σ_z)=.5
  - Buffer=1.65 σ_z
  - Increase days between margin call from 1 to 5
- Large increases in margin calls if infrastructures are fragmented
  - Eg. a bank clearing trades across 4 markets with a single integrated counterparty could experience a near 10-fold increase in margin movements if these were cleared through 4 separate CCP's. (6.62 versus .7 days between margin movements)

Implications for policy

- We have highlighted increased costs of requiring central clearing through fragmented CCP's (increased demands on collateral levels, liquidity and operational risks)
- Striking the balance between bilateral clearing and central clearing
  - Scope of central clearing requirement
  - Adjustments to non-cleared IM in light of other counterparty risk mitigates (t&c of CSA's)
- Repo and collateral reuse
  - balancing need for more elastic collateral supply with need for simplicity/transparency

Thank you

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