Calibrating limits for large interbank exposures from a system-wide perspective

BANCO DE MÉXICO

25 April 2013

Disclaimer

The views and conclusions expressed here are solely of the authors and do not necessarily reflect those of Banco de México (Banxico), the Basel Committee on Banking Supervision (BCBS), the Large Exposures Group (LEG), or its staff.

Outline

- Background
- Motivation
- Objective
- Contribution
- Key papers
- Methodology
- Type of large exposure limits
- Data
- Results
- Conclusions

Background

- March 2013: BCBS published LEG proposal
- Idea to study the calibration for LE from a system-wide perspective using network analysis was originally proposed by the LEG.
- Proposal on how to do the calibration and its main modelling features was done by the authors of this work.
- Paper largely benefited from a joint collaboration with LEG.
- Work would not have been done without the initiative of BCBS

Motivation

- Failure of a large and highly interconnected bank may lead to traumatic losses and contagion across borders.

- A tighter limit on interbank LEs is a useful tool to mitigate contagion risk.

- Key questions:
  - *How should the regulator design regime for limiting large exposures?*
  - *Is the current limit on interbank large exposures adequate?*
  - *What should be the level of the limit?*

Objective

- Show how a calibration framework based on network analysis is useful to assess the benefits of using tighter limits to reduce contagion risk

- We test different type of limits on both inter-SIB exposures and non SIBs-to-all-other banks

- We extend the analysis and perform a ‘stress test’

Contribution

- First comprehensive calibration on interbank exposures from a system-wide perspective based on actual interbank exposures.

- Contributes to the strand of the literature that intends to capture the strategic behaviour of banks by introducing three different banks' behavioural responses in the presence of tighter limits.

Key papers

- This paper is primarily based on:
  - ***Guerrero-Gómez and López-Gallo (2004)***:
    - Use a sequential default algorithm that is useful to trace the path of contagion from a trigger bank to other banks during several contagion rounds.
  - ***Cocco et al. (2009):***
    - Propose a lending preference index (*LPI*) that measures the intensity of lending activity between banks.

Methodology: Contagion Mechanism

- Sequential default algorithm can be described as a three-step process:

  (1) A bank i fails by assumption due to an unknown reason;

  (2) Any bank j fails if it has a large bilateral exposure to bank i such that its *CR* <8% threshold. CR for any bank j that is exposed to bank i failure as:

$$CR_j = \frac{RC_j - \theta_{ji} \times x_{ji}}{RWA_j - w_{ji} \times \theta_{ji} \times x_{ji}}, \qquad where$$

  CR is bank's j capital ratio,

  RC_j is bank's j regulatory capital,

  θ_{ji} is the loss given default of bank's j exposure to bank i, (i.e., θ_{ji}=100%)

  w_{ji} is the regulatory risk-weight for interbank exposures, (i.e., w_{ji}=w=20%)

  x_{ji} is the exposure of bank j to bank i; and,

  (3) Additional round occurs if a bank k fails due to contagion in step 2. Contagion stops when no additional banks go under the 8% threshold.

Methodology: Allocation Mechanism

- How would banks respond if the limit is reduced from x% to y%?
- Two polar cases for the banks' behavioural responses
  - *i. A bank with inter-bank exposures of z% exceeding the y% limit could reduce its exposure to y% and leave the (z-y)% excess amount in its account with the central bank (i.e., out of the interbank network of bilateral exposures)*
  - *ii. A bank with inter-bank exposures of z% exceeding the y% limit could reduce its exposures to y%, but increase exposures to other banks so that the size of its interbank balance sheet does not change.*
- In a real-world network: answer would lie in between (i) and (ii)
- We propose using *LPI* as proposed by Cocco et al. (2009) for modelling the process by which a bank allocates inter-bank lending that exceeds the regulatory limit. How does it work?

Methodology: Allocation Mechanism

- LPI measures the intensity of lending activity between banks.
- LPI is computed as

$$LPI_{L,B,t} = \sum_{i \in t} F_i^{L \to B} \Big/ \sum_{i \in t} F_i^{L \to all}$$

- LPI close to one means that L is an important lender for B *(strong relationship)*
- LPI is computed for the past 120 days
- In practice, banks lend to each other for different reasons and show a preference to lend to specific banks.
- In Mexico, SIBs & non SIBs find it hard to establish new lending relationships with other borrowers and show a preference to lend to specific banks.

Methodology: Allocation Mechanism

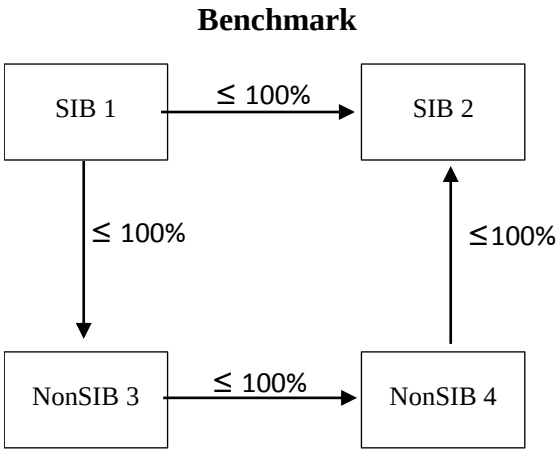
- In using *LPI*, we identify two possible allocation cases: 'partial' & 'full'.
  - ***Partial:*** *we assign (i.e., based on LPI) solely once the amount that is possible to reassign without breeching the individual limit,*
    - A remainder occurs when the receiver bank does not has enough capacity to take its corresponding excess exposure.
    - Remainder is kept at the bank's i current account with the central bank (i.e. out of the network).
  - ***Full:*** *we assign the excess exposure as much as possible, based on LPI, while the remainder is re-allocated evenly on any remaining banks counterparts that have capacity to take the excess exposure.*
    - We diversify the allocation of the excess exposure as much as possible among the bank's counterparts.
  - *In both cases, we create additional links*
  - *However, artificial lending relationships occur solely in the full allocation*

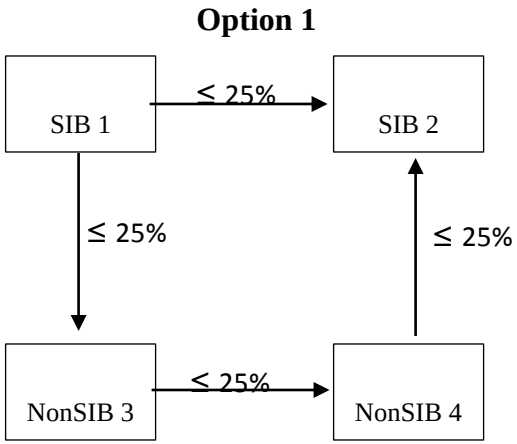
Methodology: Allocation Mechanism

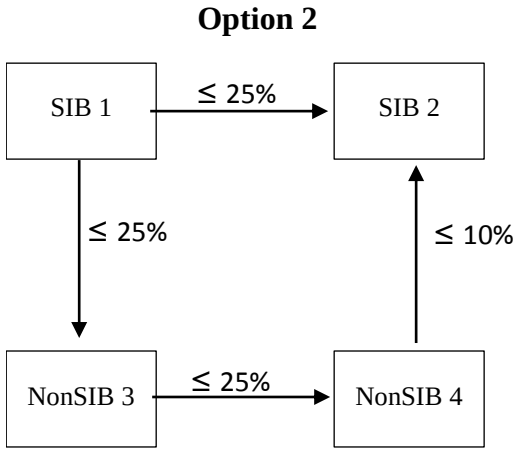
- How does it work in practice?
  - *Assume interbank market comprises five banks: A, B, C, D and E.*
  - *LPI of bank A to its 4 counterparts (i.e., B, C, D, E) are 50%, 30%, 15% & 5%, respectively*
  - *Assume that the single exposure that breaches the limit by an amount 'x' is the exposure of bank A to bank B*
  - *Excess exposure x can be assigned in the following way:*
    - 60% to bank C (i.e., 2*$LPI_{A,C}$),
    - 30% to bank D (i.e., 2*$LPI_{A,D}$),
    - and 10% to bank E (i.e., 2*$LPI_{A,E}$)

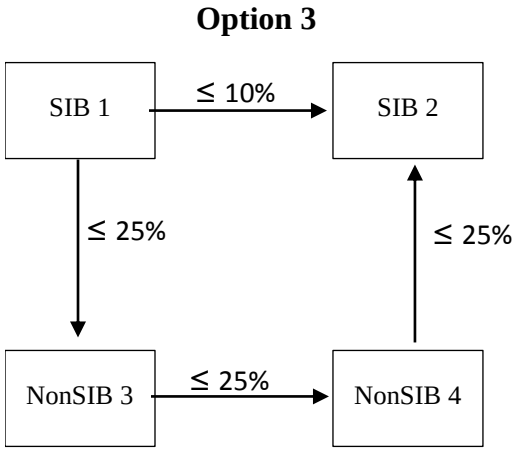
- The idea is to ensure that the full amount x is allocated among bank A counterparts.
  - *Some counterparts may not be able to absorb their full excess amount.*
  - *Partial: we leave the remainder at the central bank (i.e., out of the network)*
  - *Full: we redistribute the remainder among the counterparts that have spare capacity*

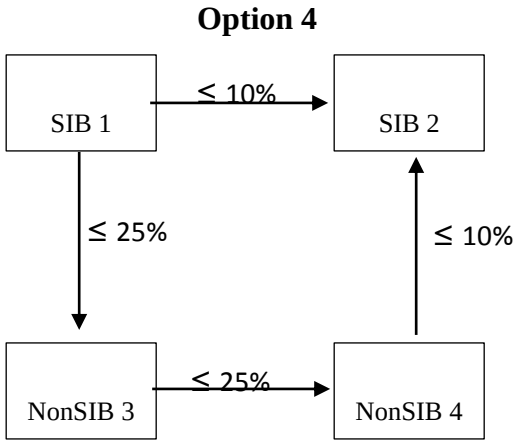
Type of large exposure limits and interbank exposures

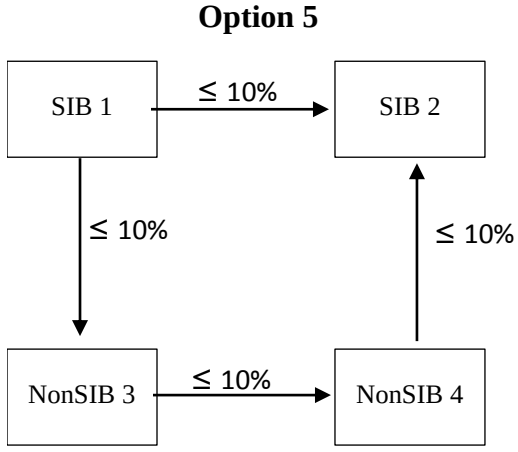






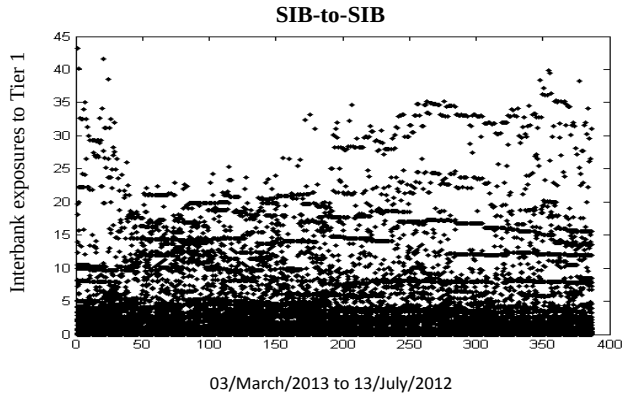


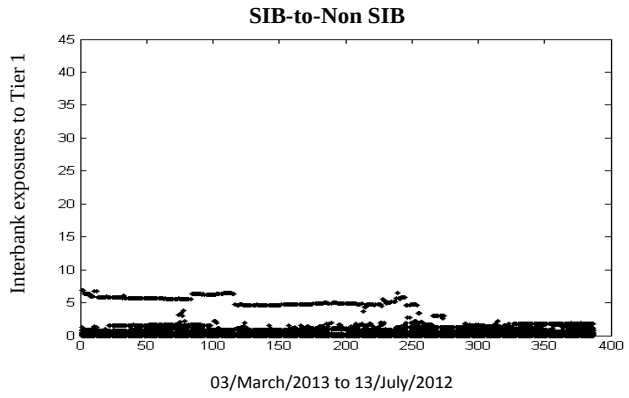


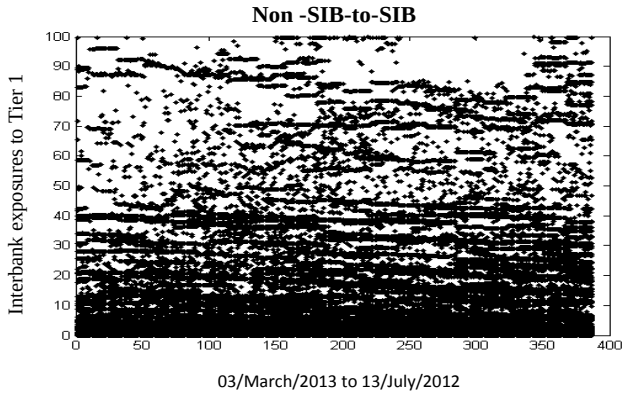


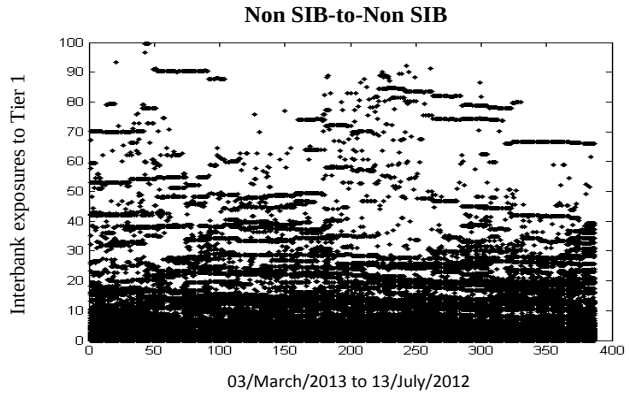
Data

Interbank exposures to Tier 1 capital for the period of March 2008 to July 2012





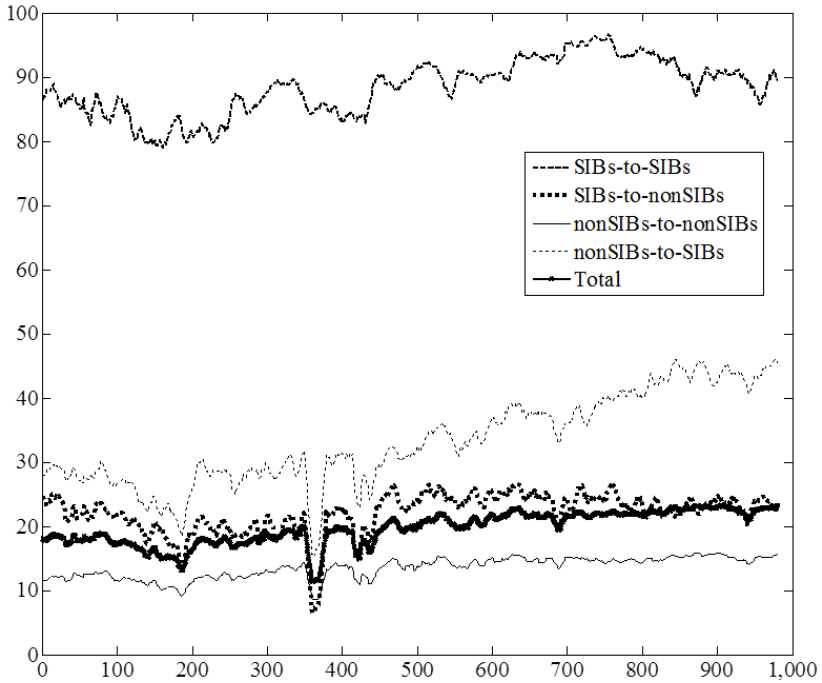




- SIBs-to-any bank exposures are significantly lower than those of non SIBs-to-any bank. The large capital base of SIBs provides an advantage.

Data

Completeness Index for the period of March 2008 to February 2012



- Complete network every bank has an exposure to all other banks
- SIBs-to-SIBs are highly interconnected as compared other bank types
- Completeness index for the SIBs-to-SIBs network is close to one.

Data

- We use daily interbank proprietary data from 2008 to 2012
- Limit applies solely for aggregate bilateral interbank exposures
- **Exposure Measure:**
  - *Exposures in the mexican interbank market include:*
  - *Uncollateralized interbank lending*
  - *Holdings of securities issued by bank counterparts*
  - *Credit components that arise in derivative transactions*
  - *All exposures are measured after credit risk mitigation*
  - *FX exposures are not included as these are cleared through CLS Bank*
- **Capital Measure:**
  - *We use Tier 1 as a measure of bank's capital*
  - *Deductions of Tier 1 Capital were already in line with Basel III*

Results

Table 4. Loss Statistics for the shock that arises from the idiosyncratic failure of each individual bank

	Benchmark	**Option 1**	**Option 2**			**Option 3**			**Option 4**			**Option 5**
	Mexican Regulatory Limit	SIB-to-any bank, Non SIB-to-any bank	SIB-to-any bank (25%)			SIB-to-Non SIB, Non SIB-to-any bank			SIB-to-Non SIB, Non SIB-to-Non SIB			SIB-to-any bank, Non SIB-to-any bank
			Non SIB-to-SIB			SIB-to-SIB			SIB-to-SIB, Non SIB-to-SIB			
Limit as a % of Tier 1 Capital	100%	25%	20	15	10	20	15	10	20	15	10	10%
Panel A												
Maximum number of bank failures in a single contagion case	4	0	0	0	0	0	0	0	0	0	0	0
SIB failures due to contagion	1	0	0	0	0	0	0	0	0	0	0	0
non-SIB failures due to contagion	3	0	0	0	0	0	0	0	0	0	0	0
Panel B*												
Share of assets destroyed due to contagion	18%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

- Risk of contagion occurs solely under the current large exposure limit in Mexico
- A 25% limit of Tier 1 or lower completely eliminates the risk of contagion.
- Result holds when we consider different banks' behavioural responses. In part, this is a consequence of the highly capitalized Mexican banking system.

Results

Table 6. Stress testing and banks' behavioural responses for limit option1: 25% Generalized tighter limit

	Benchmark	Option 1	Option 1:Partial	Option 1:Full
	Mexican Regulatory Limit	SIB-to-any bank, Non SIB-to-any bank	SIB-to-any bank, Non SIB-to-any bank	SIB-to-any bank, Non SIB-to-any bank
Limit as a % of Tier 1 Capital	100%	25%	25%	25%
Panel A				
Maximum number of bank failures in a single contagion case	11	6	15	15
SIB failures due to contagion	2	1	2	2
non-SIB failures due to contagion	9	5	13	13
Panel B				
Share of assets destroyed due to contagion	43%	27%	44%	44%
Panel C				
Total number of arcs	263	263	467	902
Average degree	9	9	15.3	31
Completeness index	23%	23%	39%	80%

- A 25% limit is no longer enough to contain the risk of contagion
- Panel A: At least one SIB fails due to contagion
- Panel B: Share of assets destroyed by contagion increases from 27% to 44%
- Panel C: Degree of interconnectedness increases significantly for 'partial' & 'full'

Results

Table 7. Stress testing and banks' behavioural responses for limit option 2: Tighter limits on Non SIB-to-SIB

	Benchmark	Option 2			Option 2: Partial			Option 2: Full		
	Mexican Regulatory Limit	SIB-to-any bank (25%)			SIB-to-any bank (25%)			SIB-to-any bank (25%)		
		Non SIB-to-SIB			Non SIB-to-SIB			Non SIB-to-SIB		
Limit as a % of Tier 1 Capital	100%	20%	15%	10%	20%	15%	10%	20%	15%	10%
Panel A										
Maximum number of bank failures in a single contagion case	11	5	5	5	14	13	10	12	11	13
SIB failures due to contagion	2	0	0	0	2	2	2	2	2	1
non-SIB failures due to contagion	9	5	5	5	12	11	8	10	9	12
Panel B										
Share of assets destroyed due to contagion	43%	26%	26%	28%	43%	43%	42%	43%	48%	48%
Panel C										
Total number of arcs	263	263	263	263	405	414	414	685	720	746
Average degree	9	9	9	9	13.8	14	14	25.3	26.2	27.1
Completeness index	23%	23%	23%	23%	35%	36%	36%	65%	67%	70%

- A tighter limit on Non SIB-to-SIB is not enough to mitigate contagion
- Even though number of bank failures is larger under 'partial' than 'full', share of assets destroyed by contagious defaults is larger for 'full' allocation.

Results

Table 8. Stress testing and banks' behavioural responses for limit option 3: Tighter limits on SIB-to-SIB exposures

	Benchmark	**Option 3**			**Option 3: Partial**			**Option 3: Full**		
	Mexican Regulatory Limit	SIB-to-Non SIB, Non SIB-to-any bank (25%)			SIB-to-Non SIB, Non SIB-to-any bank (25%)			SIB-to-Non SIB, Non SIB-to-any bank (25%)		
		SIB-to-SIB			SIB-to-SIB			SIB-to-SIB		
Limit as a % of Tier 1 Capital	100%	20%	15%	10%	20%	15%	10%	20%	15%	10%
Panel A										
Maximum number of bank failures in a single contagion case	11	5	5	5	10	10	10	15	14	15
SIB failures due to contagion	2	0	0	0	0	0	0	2	1	2
non-SIB failures due to contagion	9	5	5	5	10	10	10	13	13	13
Panel B										
Share of assets destroyed due to contagion	43%	2%	2%	2%	5%	5%	5%	44%	19%	44%
Panel C										
Total number of arcs	263	263	263	263	394	405	409	661	675	694
Average degree	9	9	9	9	13.4	13.7	13.8	24.3	24.7	25.3
Completeness index	23%	23%	23%	23%	34%	35%	35%	62%	63%	65%

- A tighter limit on SIB-to-SIB exposures reduces contagion for the 'partial' and the 'no allocation' cases. Share of assets destroyed by contagious defaults remains low.
- There is a non-linear effect in the full allocation case.

Results

Table 9. Stress testing and banks' behavioural responses for limit option 4: Tighter limits for SIB-to-SIB and NonSIB-to-SIB

	Benchmark	Option 4			Option 4: Partial			Option 4: Full		
	Mexican Regulatory Limit	SIB-to-Non SIB, Non SIB-to-Non SIB (25%)			SIB-to-Non SIB, Non SIB-to-Non SIB (25%)			SIB-to-Non SIB, Non SIB-to-Non SIB (25%)		
		SIB-to-SIB, Non SIB-to-SIB			SIB-to-SIB, Non SIB-to-SIB			SIB-to-SIB, Non SIB-to-SIB		
Limit as a % of Tier 1 Capital	100%	20%	15%	10%	20%	15%	10%	20%	15%	10%
Panel A										
Maximum number of bank failures in a single contagion case	11	5	5	5	6	6	7	10	10	13
SIB failures due to contagion	2	0	0	0	0	0	0	0	0	1
non-SIB failures due to contagion	9	5	5	5	6	6	7	10	10	12
Panel B										
Share of assets destroyed due to contagion	43%	1.5%	1.5%	1.5%	1.5%	1.5%	3.1%	3.8%	3.8%	15.7%
Panel C										
Total number of arcs	263	263	263	263	405	425	429	685	734	779
Average degree	9	9	9	9	13.9	14.3	14.4	25.3	26.5	28
Completeness index	23%	23%	23%	23%	36%	36.5	37%	65%	68%	72%

- A tighter limit for both SIB-to-SIB and Non SIB-to-SIB is not effective in reducing contagion in the 'full' allocation case.
- The non-linearity in the full allocation case as measured by the share of defaulting assets due to contagion persists.

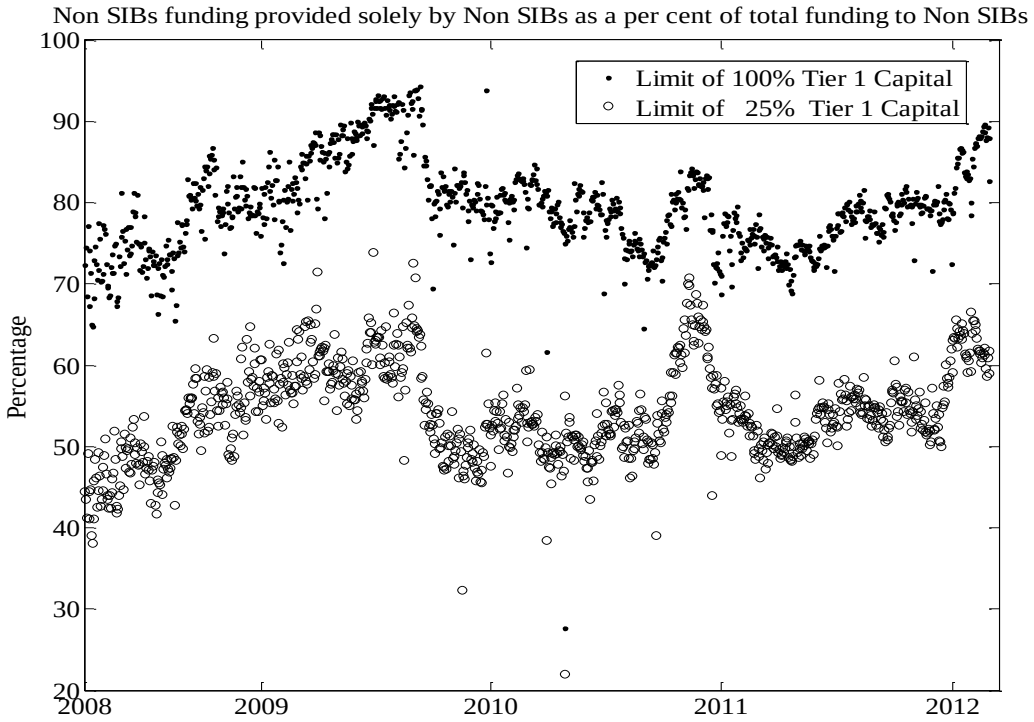
Results

Table 10. Stress testing and banks' behavioural responses for limit option 5: 10% Generalized limit

	Benchmark	Option 5	Option 5:Partial	Option 5:Full
	Mexican Regulatory Limit	SIB-to-any bank, Non SIB-to-any bank	SIB-to-any bank, Non SIB-to-any bank	SIB-to-any bank, Non SIB-to-any bank
Limit as a % of Tier 1 Capital	100%	25%	25%	25%
Panel A				
Maximum number of bank failures in a single contagion case	11	0	0	0
SIB failures due to contagion	2	0	0	0
non-SIB failures due to contagion	9	0	0	0
Panel B				
Ratio of total assets destroyed by contagion	43%	0%	0%	0%
Panel C				
Total number of arcs	263	263	394	661
Average degree	9	9	13.4	24.3
Completeness index	23%	23%	34%	62%

- A generalized 10% limit fully eradicates contagion risk even for the 'full' allocation case.
- Efficiency costs may be especially large for nonSIBs.
- There is a need to study non SIBs funding.

Non SIB Funding



- Non SIB-to-any bank exposures are relatively large.
- A generalized 25% limit will reduce Non SIB funding provided by Non SIBs on average from 80% to 55%..
- An exemption of large exposure limits for small banks may be desirable.

Conclusions

- A limit of 25% of Tier 1 Capital is enough to contain the risk of contagion under regular conditions
- A limit of 25% of Tier 1 Capital is not enough under a severe stress scenario.
- A limit of 20% solely for SIB-to-SIB exposures reduces the risk of contagion under the 'no allocation' or 'partial allocation' scheme.
  - *Benefit:* *reduction in the risk of contagion*
  - *Cost:* *regulatory disclosure of the identity of SIBs.*

- A limit of 10% fully eradicates contagion. However, more research is needed for introducing tighter limits for small banks.
  - *Failure of small bank does not bear the same cost as the failure of large bank.*
  - *Funding requirements of small banks are large due to their relatively small capital base*
  - *Small banks may face difficulties in obtaining financing during periods of stress.*

Main References

- Basel Committee on Banking Supervision (BCBS) (2013). Supervisory framework for measuring and controlling large exposures. Consultative Document. Available at: http://www.bis.org/publ/bcbs246.pdf

- Guerrero-Gómez, S., and López-Gallo, F. (2004). 'Interbank exposures and systemic risk assessment: an empirical analysis for the Mexican banking sector', Mimeo.

- Cocco, F., Gomes, F., and Martins, N. (2009). 'Lending relationships in the interbank market', Journal of Financial Intermediation, Vol.18, pp. 24–48.


BANCO DE MÉXICO
www.banxico.org.mx