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COVID, CREDIT, AND CONTAGION RISKS TO ASEAN+3 FINANCIAL SYSTEMS¹

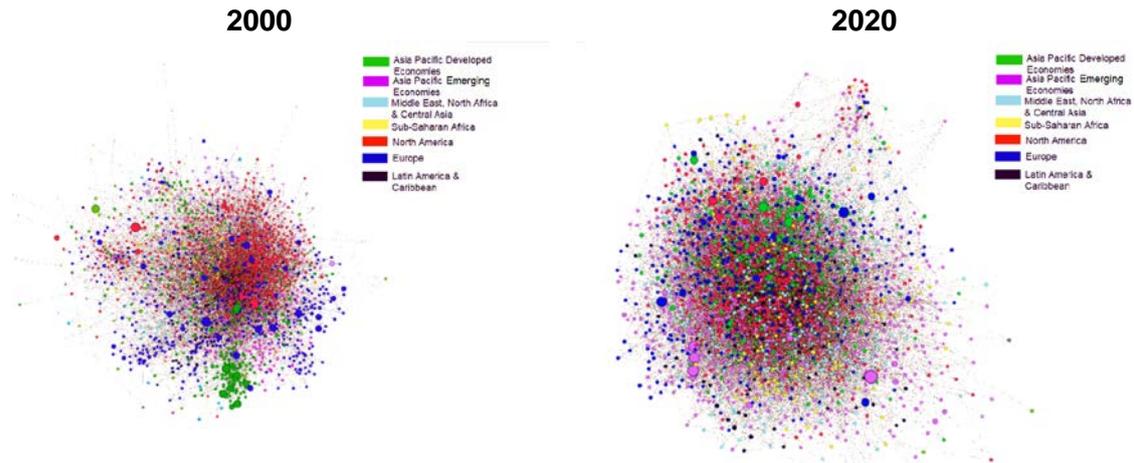
I. Introduction

- 1. The COVID-19 pandemic has caused widespread financial difficulties for businesses and individuals.** National lockdowns have seen economic activity come to a virtual standstill, firms have been shuttered and workers have been furloughed or let go, while bearing the burden to pay rents, salaries, debt interests and principals. Households, in the face of falling income and loss of employment, are experiencing difficulty paying their rents and fulfilling their mortgage and other loan obligations.
- 2. As a result, banks are confronted with sharp drops in revenue and rising credit risks.** Revenues are affected through the loss in (1) fees from servicing corporate clients, whose businesses are disrupted; (2) interest margins from sharply lower demand for commercial and retail loans; (3) wealth management income from rising risk aversion toward investment assets, and (4) delayed or defaulted interest payments, among other income sources. Concurrently, banks are facing increasing bad loans, as corporate customers go under and unemployed retail borrowers struggle to service their obligations.
- 3. In an increasingly interconnected global financial system, banks' own credit distress could have significant ripple effects.** Over the past 20 years, the global financial system has morphed from more disparate, regional businesses into an amalgam of highly interconnected networks (Figure 1). Consequently, contagion arises because financial institutions (FIs) are interlinked through borrowing-lending relationships, capital market transactions, common ownership structures, and market sentiment. The risk of contagion tends to rise during turbulent times ([IMF, 2009](#); Diebold and Yilmaz, 2014), as a result of the pro-cyclical nature of leverage, prices and market herd behavior. Moreover, the ripple effects could push other FIs into distress through second-round effects (Figure 2).
- 4. In the ASEAN+3 region, regulators in many jurisdictions have introduced measures to alleviate the pressures faced by banks and their customers.** They are affording banks some regulatory forbearance and, in turn, encouraging banks to provide continuing support to borrowers (see Appendix I). The former includes leniency toward banks' NPL classifications, and/or a halt in enforcement of capital, liquidity and/or leverage requirements, so that banks do not have to realize any balance sheet impairment for the time-being. Meanwhile, banks grant borrowers a grace period for servicing their interest payments or repaying their maturing loans. Such measures release individual banks from realizing certain losses and prevent any distress from spreading further, thereby reducing the potential costs to the financial system as a whole—at least for the time being.

¹ Prepared by Wei Sun (Financial Surveillance); reviewed by Li Lian Ong (Financial and Regional Surveillance); authorized by Hoe Ee Khor (Chief Economist). The views expressed in this note are the author's and do not necessarily represent those of the AMRO or AMRO management.

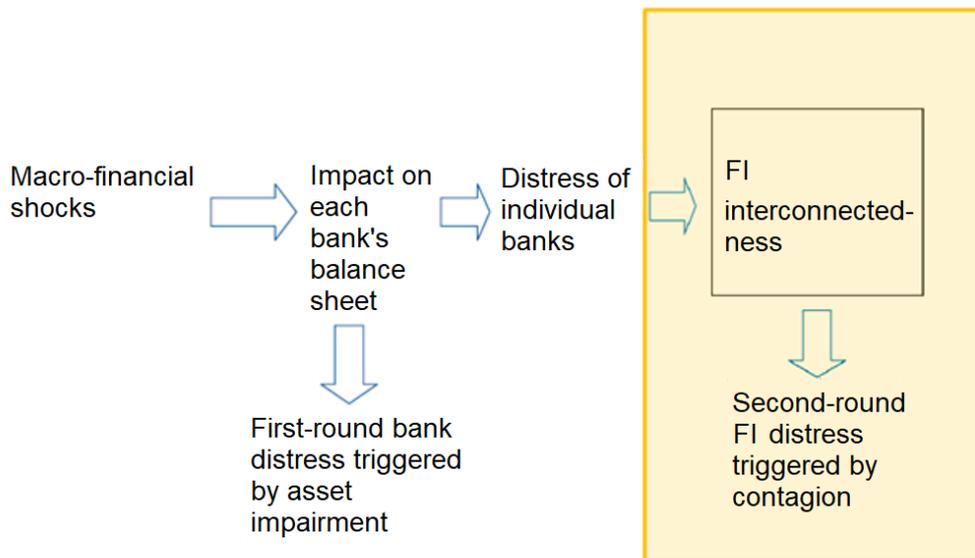
5. In this note, we stress test for the **additional expected costs to the wider financial system from shocks to individual ASEAN+3 banks as a result of the pandemic**. Here, “additional” loss comprises two components: (1) the loss on top of the direct credit costs already booked in the financial system prior to the pandemic;² and (2) the losses attributable to financial interconnectedness, that is, the costs to the wider financial system beyond the direct damage to individual banks’ asset quality (see Appendix II).

Figure 1. Growing Integration of the Global Financial System



Source: Credit Research Initiative of the National University of Singapore; and author’s calculations.

Figure 2. First- and Second-Round Bank Distress



Source: Author/

² Under Basel III regulations, the expected losses (ELs) are based on forward-looking measurements of credit risks and should be covered by provisions (unexpected losses should be absorbed by capital).

II. Data and Concept

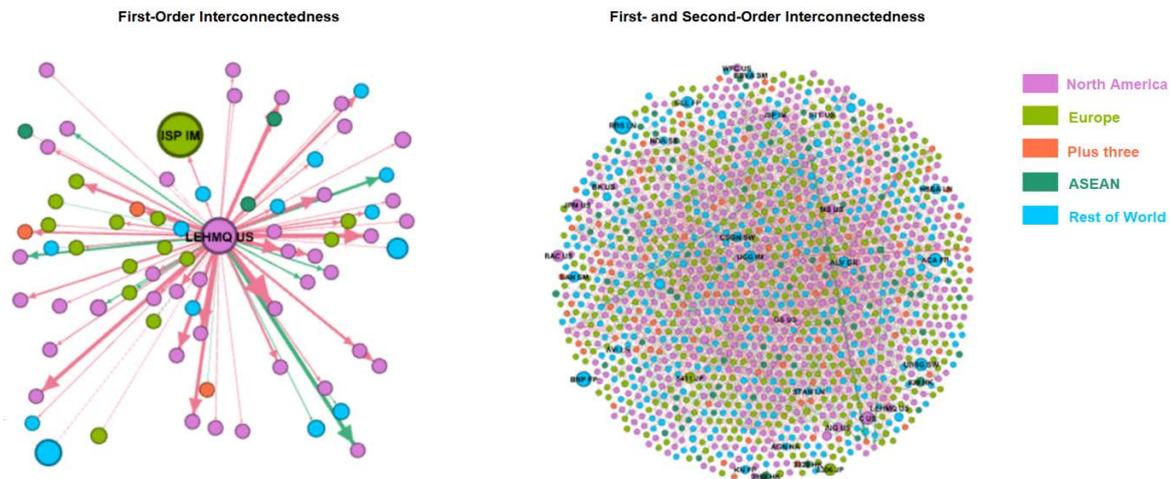
6. **The total *incremental* expected losses to the wider financial system from a bank's distress may be attributable to two key sources.** They comprise (1) direct credit losses due to defaulted obligations in a borrowing-lending relationship; and (2) collateral damage due to contagion through financial interconnectedness. Hence, estimating the *expected* losses to a financial system should take into account the likely materialization of the following risks:

- ***Default risk, which is the likelihood that a bank is unable to pay off its debt obligations.*** To capture this risk, we use the probability of default (PD) introduced by [Chan-Lau and others \(2018\)](#) and Duan and others (2012), and computed by the Credit Research Initiative of the National University of Singapore. The PD data are available for about 2,000 exchange-listed banks and insurance companies around the world. By construction, this indicator incorporates a wealth of information ranging from macro-financial conditions, firm fundamentals to stock market movements. For any bank whose default risk has risen, the cost is reflected in the deterioration in the asset quality of its creditors and any additional provisions they have to set aside.
- ***Contagion risk arising from a myriad of factors,*** key among them being borrowing-lending relationships, common business models and stakeholders, capital market transactions, and market sentiment. To trace how such risks are transmitted, we develop an innovative measure of financial interconnectedness using co-movements of PDs. We then construct a global financial network comprising the 2,000 global FIs, linking regional banks with rest of the world's financial system. The costs arising from a bank's contagion risk are the weakening creditworthiness of its connected FIs in the network and the balance sheet impairment of *their* respective creditors.

7. **History has shown that the realization of contagion risks can result in significant losses beyond what an FI's balance sheet shows.** The failure of Lehman Brothers in 2008, during the global financial crisis, epitomized how the interconnectedness of global financial networks can introduce and magnify systemic risks through the entire global financial system. Lehman was the eighth largest listed bank in the United States and the 35th largest in the world, and would not have made it to the Financial Stability Board's (FSB's) list of global systemically important banks (G-SIBs), had there been one at the time, and was allowed to go under with previously unimagined consequences. Its collapse highlighted the significance of "too-interconnected-to-fail" FIs beyond the "too-big-to-fail" (Figure 3):

- Lehman's immediate network of "counterparties" through "first-order" connections, numbered an estimated 75 in August 2008, the month before its bankruptcy. Eleven of those counterparties subsequently went into bankruptcy or were suspended from their respective exchanges shortly after Lehman's collapse.
- Lehman's financial network becomes much denser, encompassing two thirds of the global FIs once the second-order interconnections via the immediate 75 are included. It highlights the widespread contagion that could occur if the shocks to the first-order counterparties are not contained in a timely manner.

Figure 3. Example: Financial Networks Surrounding Lehman Brothers, August 2008



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: In the networks, each node denotes a unique FI. The size of the node represents the FI's total liability, and the color its country of domicile. Two nodes are connected by a directional arrow, whose thickness represents the extent to which the PD of the "risk sender" affects that of the "risk receiver."

III. Analysis

8. **We place the listed ASEAN+3 banks into two separate groups to facilitate analyses of their credit and contagion risks:**

- **By systemic importance.** The first group comprises 64 publicly listed banks, officially designated G-SIBs by the FSB (FSB, 2019), as well as the likely domestic systemically important banks (D-SIBs). Our D-SIB list—which may differ from the official ones—is constructed based on public disclosure, media reports, and our own estimations. Where D-SIBs are not public information, we rank the domestic banks by asset size as a rough and ready proxy, although interconnectedness, complexity, cross-jurisdiction activity, and substitutability are other key characteristics of systemic importance (IMF/BIS/FSB, 2009; Basel Committee on Banking Supervision, 2018).³
- **By economy.** The second group consists of all publicly listed banks, investment banks, and securities firms (hereafter "banks").⁴ For major economies with hundreds of listed banks, only the largest 50 by asset size are included (see Appendix III).⁵

9. **We subsequently estimate, via a stress test, the incremental expected losses that each ASEAN+3 bank could impose on the wider financial system.** We apply the actual PD increase since January 2020 (prior to the global spread of the pandemic) of 20 basis points to each bank. The magnitude is relatively small in the context of some major stress events for emerging market banking sectors in the Asia-Pacific region—the Asian

³ We include Citigroup, HSBC Holdings, and Standard Chartered Bank to proxy for their unlisted Asian subsidiaries, which are considered D-SIBs in Hong Kong, China (hereafter "Hong Kong") and Singapore (Lee, 2015; Moody's Analytics, 2019). HSBC and Standard Chartered Bank, in particular, generate most of their revenues in Asia.

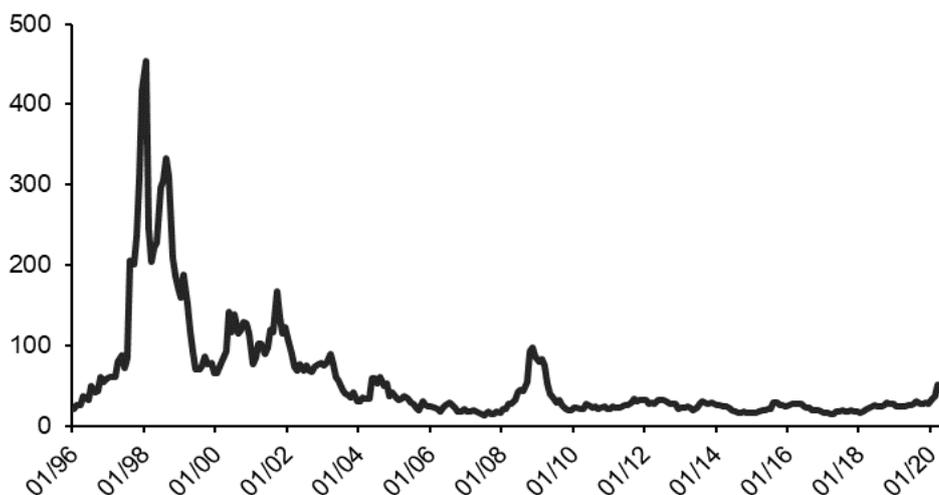
⁴ The sample does not include banks from Brunei Darussalam, Cambodia, Lao PDR, and Myanmar, because the dataset does not have any publicly-listed banks from these economies.

⁵ The results for the smaller banks are available from the author upon request.

financial crisis (400 basis points), the global financial crisis (50 basis points), and the Taper Tantrum (10 basis points). That said, it is actually a sizeable shock given that, historically, 20 basis points represent the difference in PDs between typical investment-grade and speculative-grade entities ([Credit Research Initiative of the National University of Singapore, 2020](#)). Prior to the pandemic, the PDs of most of the banking systems in the region were at single digits, equivalent to investment grade on the Standard & Poor's rating scale. We observe several trends:

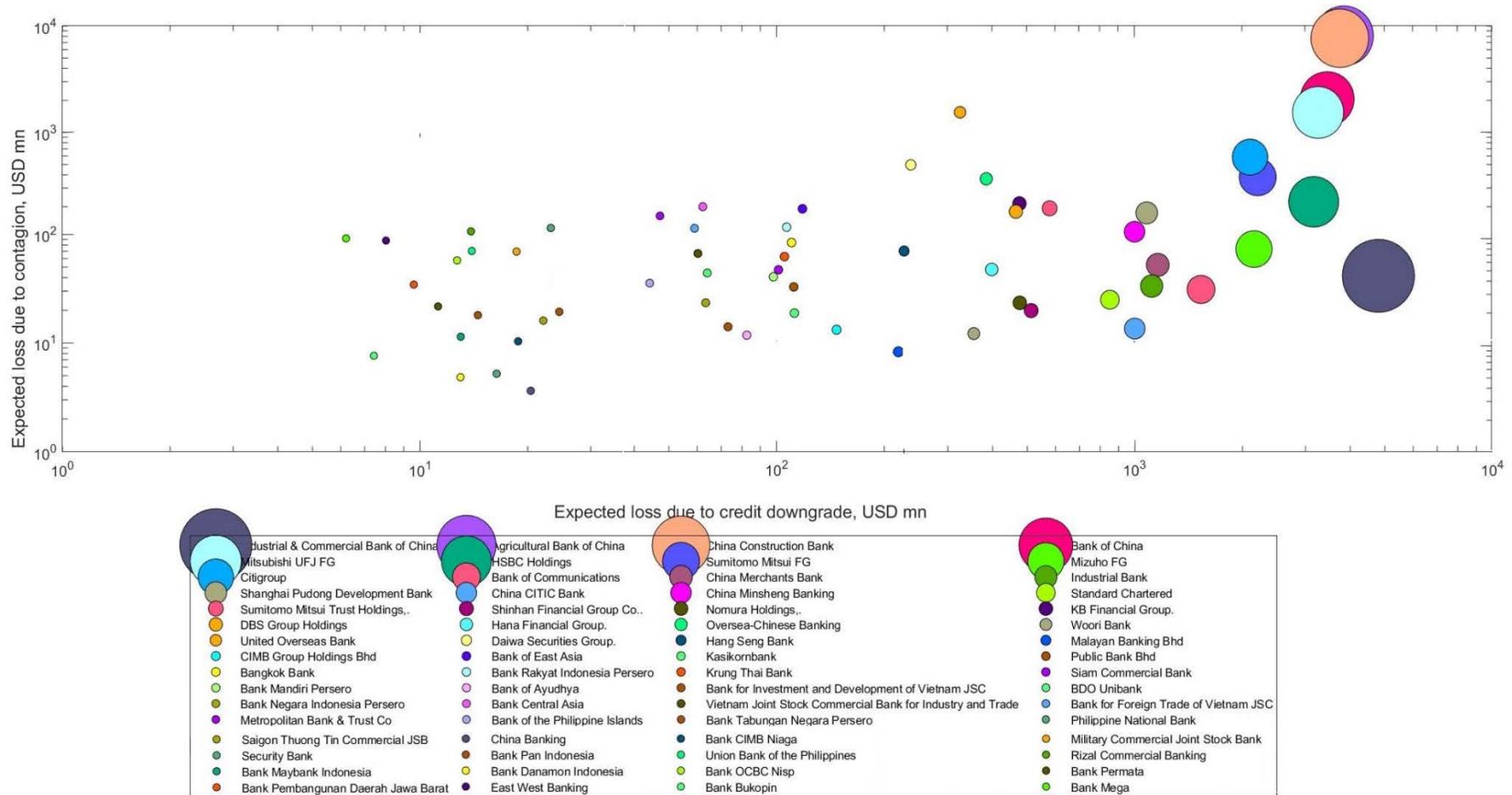
- Bank size, unsurprisingly, plays an important role in determining the magnitude of both loss measures. With trillions of US dollars in liabilities, shocks to ASEAN+3 G-SIBS—China's state-owned banks and Japan's mega banks—would impose the largest expected credit losses on their creditors (Figure 4). Moreover, they would, by definition, inflict collateral losses on many others given their systemic importance.
- Some of the D-SIBs also appear to be highly interconnected, and could cause sizable collateral losses to the financial system (i.e., smaller bubbles on the upper-side of Figure 5). D-SIBs from Singapore and Japan are among the most interconnected in the region.
- For the G-SIBs, a 20 basis point increase in PDs would result in **incremental** expected credit losses amounting **up to** USD 10 billion, and another USD 10 billion in **incremental** expected contagion losses, to the broader global financial system. The **incremental** credit losses caused by D-SIBs in the region range from around USD 10 million (e.g., the Philippines and Indonesia) to more than USD 1 billion (e.g., China), while expected **incremental** contagion losses range from USD 10 million to USD 1 billion.

Figure 4. Asia-Pacific: PDs of Emerging Market Banking Sectors
(Basis points)



Sources: Credit Research Initiative of the National University of Singapore.

Figure 5. ASEAN+3: Incremental Expected Default Losses and Estimated “Collateral Damage” of G-SIBs and D-SIBs from a 20 Basis Point Increase in PDs



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

10. The additional expected losses from credit and contagion risks could have important ramifications for the affected FIs and at the extreme, for the fiscal purse.

The aggregated expected losses caused by G-SIBs and D-SIBs in individual financial systems from a collective 20 basis point shock to PDs—that is, the PDs of all systemically important banks in one economy increase by 20 basis points—could range as high as USD 42 billion for China and between USD 4 and 5 billion for the regional financial centers (Table 1). A large proportion of the contagion/collateral losses caused by major ASEAN banks would be borne by their domestic FI counterparts because of close interlinkages and, to some extent, those in China and Japan. In contrast, banks in the Plus-3 economies would affect each other more, given their relative sizes and likely close business connections. The number and size of G-SIBs and D-SIBs vary across jurisdictions, and each may be of different relative importance to its own financial system.

11. Actual failure of any one of the G-SIBs or D-SIBs could have massive implications for the global or regional financial system. If we were to assume a 9,000 basis point increase in PDs, that is, an almost certain likelihood of failure (as happened with Lehman's during the GFC) for a G-SIB or D-SIB, incremental expected credit losses could top USD 1 trillion plus up to another USD 1 trillion from the contagion fallout (Figure 6).⁶ Accordingly, any collective default would make the total losses even more sizable. Importantly, our analyses are up to second order contagion (where the large proportion of increases occur), so the estimated collateral damage amount would be larger.

IV. Policy Implications

12. In the current economically stressed pandemic environment, concerns about financial stability have heightened significantly. As countries fall into recession, the deterioration in banks' asset quality and corresponding rise in credit risks—as corporate bankruptcies and unemployment rise—also increase the likelihood of collateral damage from contagion in an increasingly interconnected global financial system. In the event that banks' provisions and capital are insufficient to absorb any resulting losses, and they are unable to raise the requisite capital from the market, the ones that are too-big-to-fail or too-connected-to-fail would require sovereign bailouts, which would impact the fiscal purse.

13. This study estimates the incremental expected losses to the financial system from the rising credit and contagion risks of regional banks. The aim is to provide financial regulators with a gauge of the potential magnitude of any financial fallout from the ripple effects ultimately triggered by the pandemic, and allow fiscal authorities to gauge the contingent claims from the banking system if any provision or capital buffers pre-pandemic are not sufficient to cover such additional costs. The methodology and estimates in this study could therefore be a useful reference for authorities to compute their fiscal costs for managing the current financial distress and weigh policy actions.

⁶ As a comparison, the 9,000 shock to Lehman's PD resulted in an estimated incremental expected credit loss of USD 360 billion on its direct creditors and collateral damage of USD 385 billion to other US financial firms.

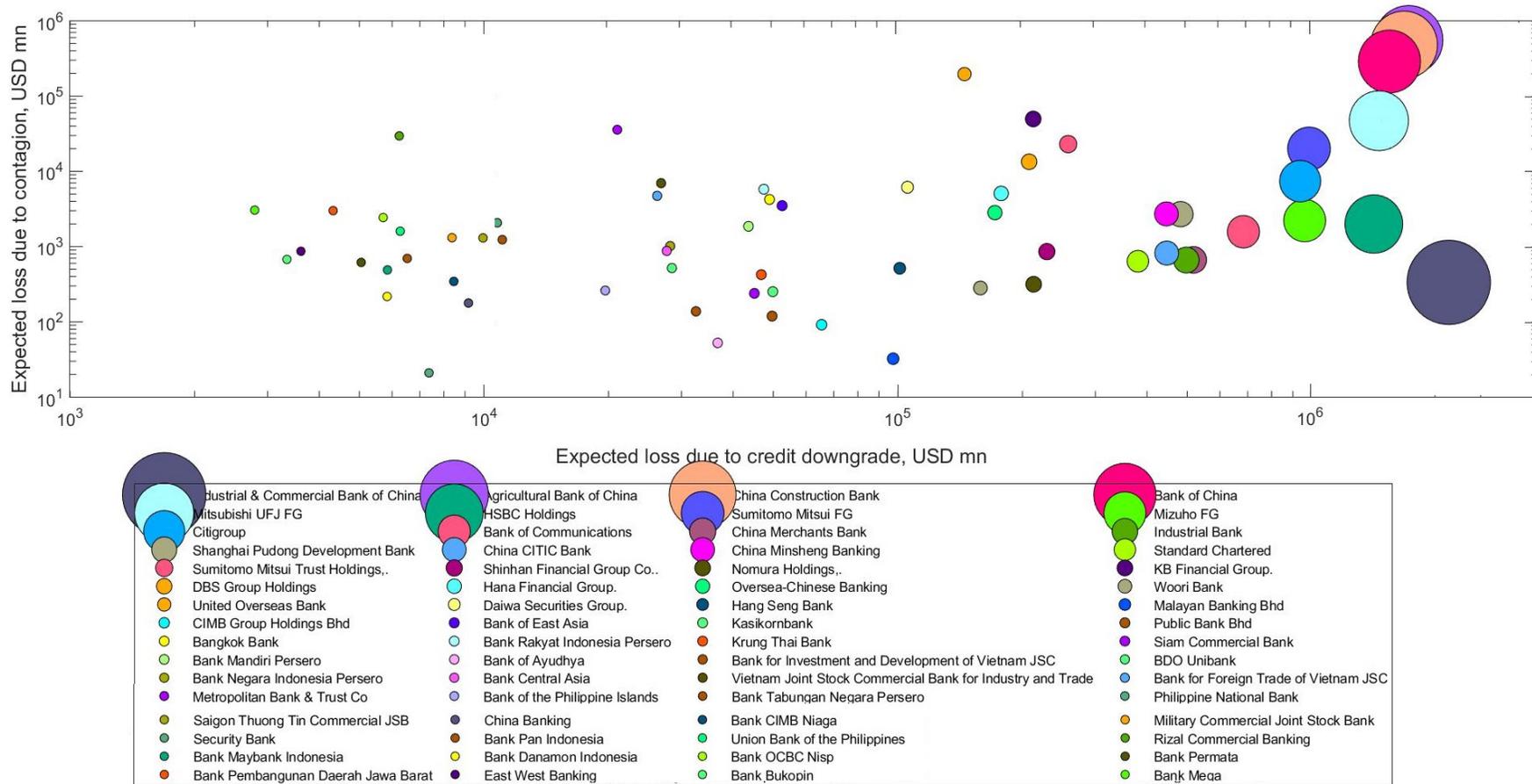
Table 1. ASEAN+3 Banks: Incremental Expected Credit Losses and “Collateral Damage” caused by G-SIBs and D-SIBs of a Particular Economy from a Collective 20 Basis Point Increase in PDs
(In millions of US dollars)

Loss Component	Financial System									
	China	Japan	Korea	Hong Kong	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Collateral damage due to contagion from source entity										
(1) to own financial system	19,777.0	2,541.9	226.8	292.0	287.6	3.5	505.3	2,926.8	133.0	225.5
(2) to Plus 3 financial system (excluding own)	459.6	74.3	34.7	299.8	257.0	7.6	191.0	302.3	48.5	83.3
(3) to ASEAN financial system (excluding own)	2.2	8.1	1.7	21.0	19.6	1.0	3.7	38.9	2.1	2.4
(4) to rest of world financial system	175.5	62.2	35.1	206.3	80.8	45.2	183.9	609.7	80.9	17.5
(5) Expected credit loss from source entity to direct creditors	22,809.2	8,939.8	1,748.3	4,788.7	461.4	477.9	252.2	1,178.3	511.2	233.0
Number of G-SIBs and D-SIBs	10	6	4	5	14	3	9	3	5	5

Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: The listed entities of HSBC Holdings and Standard Chartered Bank proxy for their Asian subsidiaries, and are included in the Hong Kong sample to reflect the location of their regional headquarters.

Figure 6. ASEAN+3: Incremental Expected Default Losses and Estimated “Collateral Damage” of G-SIBs and D-SIBs from a 9,000 Basis Point Increase in PDs



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$, $10^5=100,000$, $10^6=1,000,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities..

14. **Regulatory forbearance is a powerful tool for “buying time” during a crisis, but a credible and transparent exit strategy is crucial if confidence in the financial system is to be maintained.** Such benevolent measures can only be temporary, while policymakers focus on the more immediate, pressing needs of the economy. However, the actual problems need to be addressed sooner rather than later, and for the relevant ASEAN+3 banking systems, exit policies and official guidance are now required in two areas: (1) when and how banks eventually wean borrowers off the postponement in debt servicing, while recognizing that not all will have the means to do so at the same time; and (2) how authorities should phase out regulatory forbearance while allowing banks time to repair their balance sheets and normalize crucial lending to the economy post-pandemic.

15. **In this regard, exit strategies should incorporate several considerations.** In particular, they should be clear on: (1) timing, that is, a schedule of steps for exiting; (2) recapitalization of viable banks; (3) burden sharing, that is, the amount of estimated losses and how those losses may need to be shared among banks’ debtholders and shareholders, borrowers, and the public purse; and (4) the strategy for managing non-performing loans, that is, the establishment or rejuvenation of asset management companies to take over and manage the banking system’s bad assets.

16. **It is critical that regulators engineer a “soft-landing” for the financial sector as the pandemic recedes.** The experience from previous crises show that the resulting fiscal costs could be substantial. Since the early 1980s, financial crises among the ASEAN+3 countries incurred direct fiscal costs averaging 20 percent GDP or the equivalent of 31 percent of financial sector assets, while increasing public debt by an average of 19 percent of GDP ([Laeven and Valencia, 2018](#)). Given the already significant fiscal spending required to support regional economies through the hardships imposed by the pandemic, there may be little policy space left to bail out the banking sector if a financial crisis were to occur.

Appendix I. ASEAN+3: Pandemic Policies

Appendix Table 1. Selected ASEAN+3 Financial Sectors: Private Sector Initiatives and Regulatory Forbearance, as of end-May 2020

Economy	Private Sector Initiatives	Regulatory Forbearance
China	<ul style="list-style-type: none"> Announced that the CBIRC will work with banks to undertake loan extensions, and help to increase financing and reduce financing cost for SMEs. 	<ul style="list-style-type: none"> (The PBC and CBIRC) signaled the possible postponement of the implementation of the new rules on asset management. (Note: The new rules will greatly weigh on shadow banking activities). The PBC and the CBIRC are conducting technical assessments.
Korea	<ul style="list-style-type: none"> Extended maturity of existing loans and guarantees for SME borrowers of policy banks. Extended new loans with lower interest rates or special guarantees to small merchants and self-employed business owners affected by COVID-19. Introduced loan deferment programs for 6 months for financially vulnerable individuals affected by the outbreak. 	<ul style="list-style-type: none"> Announced temporary relaxation of regulated loan-to-deposit ratio applied to self-employed business owners and small merchants. Eased loan-to-deposit ratio applied to saving banks and mutual finance companies.
Hong Kong, China	<ul style="list-style-type: none"> Asked banks to consider arrangements to automatically offer extensions of loan tenor or principal repayment holidays to qualified SMEs without requiring them to make an application. Borrowers just need to indicate whether they will accept or not. (HKMCI and banks) entered advanced stage of preparatory work for the special 100 percent Loan Guarantee under the SME Financing Guarantee Scheme announced in the Budget. (Banks) extended further the repayment period of trade financial facilities for SME customers in the import-export and manufacturing sectors facing cash-flow pressure due to delays in shipments; considered allowing more customers to apply to convert trade financing lines into temporary overdraft facilities. 	<ul style="list-style-type: none"> Announced a further cut to the countercyclical capital buffer (CCyB) for banks, following the earlier cut on Jan 29 this year, and indicates that it has used a forward-looking approach to “undershoot” the CCyB. Info and indicators used to set the CCyB signals a CCyB of 1.75 percent, but projections suggest that Q1 data will imply that the CCyB should be set lower than this Dispensed advice to banks regarding more flexible loan treatment for this period of heightened stress. Accordingly, banks need not categorize the loans as non-performing nor make any provision. A revision of repayment terms will generally be regarded as “commercial” if it does not involve a reduction in principal repayment, and the applicable interest rates of the loan are not substantially below prevailing market levels.”
Indonesia	<ul style="list-style-type: none"> Granted BI the authority to disburse sharia short-term liquidity loans or financing for systemic or non-systemic banks that face liquidity problems. BI is also allowed to give special liquidity loans to systemic banks that face liquidity issues but are not eligible for sharia short-term liquidity loans. Allowed systemic banks to request special liquidity loans from BI in the event that that still face liquidity problems after receiving the short-term loans. The central bank would then coordinate with the Financial Services Authority (OJK) to hold Financial System Stability Committee (KSSK) meetings to decide whether the special loans will be granted. Lowered credit card interest rate to 2.0 percent per month from the current 2.25 percent and reduced minimum credit card payment amount from 10 to 5 percent of total outstanding credit. Lowered late payment penalty from the current 3 percent of the outstanding amount or a maximum IDR 150,000 (USD 9.51) to 1 percent or a maximum of IDR 100,000. The relaxation will take effect starting on May 1, 2020 until Dec 31, 2020. 	<ul style="list-style-type: none"> Eased rules governing loan restructuring for SMEs to allow banks to restructure loans regardless of credit ceiling limits; SMEs would be eligible for loans of up to 10 billion rupiah (USD 655,000) if they have good credit history and have the capacity to pay back the loan. Announced that the implementation of Basel III reform standards in Indonesia, which include the calculation of risk weighted assets (RWA) for operational, credit and market risks, and credit valuation adjustment (CVA) will be postponed to January 1, 2023.
Malaysia	<ul style="list-style-type: none"> Urged banks to offer loan/financing repayments for 6 months (Apr 1–Sep 30, 2020) to individuals and SMEs. Announced that life insurers and family takaful (Islamic insurance) operators to allow payment deferrals and facilitate requests for flexibility by policyholders and takaful participants. 	<ul style="list-style-type: none"> Allowed banking institutions to draw down on capital and liquidity buffers to support lending activities until end-2020. These measures include drawing down on the capital conservation buffer of 2.5 percent, operating below the minimum liquidity coverage ratio of 100 percent, and utilizing the regulatory reserves that were set aside during periods of

Economy	Private Sector Initiatives	Regulatory Forbearance
		<p>strong loan growth. The minimum NFSR will also be lowered from 100 percent to 80 percent.</p> <ul style="list-style-type: none"> • Allowed banks flexibility to meet timelines for regulatory submissions. • Announced the reduction of the interest rate (IRCC) and profit rate (PRCC) stress factor caps applied under the Risk-Based Capital Framework for Insurers and Risk-Based Capital Framework for Takaful Operators (Frameworks), respectively, from 40 percent to 30 percent with effect from Mar 31, 2020.
Philippines		<ul style="list-style-type: none"> • Implemented time-bound, temporary relaxation of BSP regulations on compliance reporting by banks, calculation of penalties on required reserves, and single borrower limits, and reduction in the term spread on rediscounting loans relative to the overnight lending rate to zero. • Increased single borrower limits (SBL). Increase in the SBL under Section 362 of the Manual of Regulations for Banks (MORB)/Section 342-Q of the Manual of Regulations for Non-Bank Financial Institutions (MORNBF) from 25 percent to 30 percent for a period of six (6) months from Mar 19, 2020, pursuant to national interest. • Relaxed the maximum penalty that may be imposed for reserve deficiencies under Section 255 of the MORB/Section 215-Q of the MORNBF. The maximum penalty that may be imposed by the BSP for reserve deficiencies shall be the Overnight Lending Facility rate plus 50 basis points: Provided, that the maximum reserve deficiency of the BSFI shall be 200 basis points above the reserve requirement. • Extended the period of compliance with BSP supervisory requirements. • Allowed reclassification of debt securities measured at fair value to the Amortized Cost Category. • Provided relief to reduce the impact of mark-to-market losses. • Temporarily reduced the credit risk weights of loans granted to MSMEs that are current in status. • Assigned a lower risk weight for MSME exposures that are covered by guarantees. • Deferred the implementation of the revised risk-based capital framework applicable to stand-alone thrift banks, rural banks and cooperative banks. • Allowed covered banks and quasi-banks to utilize the capital conservation buffer and Liquidity Coverage Ratio buffer during state of health emergency.
Singapore	<ul style="list-style-type: none"> • (MAS and the financial Industry) announced support for individuals and SMEs affected by the pandemic. The package has three components: <ul style="list-style-type: none"> - help individuals meet their loan and insurance commitments; - support SMEs with continued access to bank credit and insurance cover; and - ensure interbank funding markets remain liquid and well-functioning. 	
Thailand	<ul style="list-style-type: none"> • Allowed banks more flexibility to approve loans in order to give debtors sufficient liquidity. • Called on commercial banks to lower the minimum payment limit for credit-card holders to 5 percent from the 10 percent ceiling. • Reduced commercial banks' contributions to bailout fund to 0.23 percent from 0.46 percent. • (Commercial banks and SFIs) agreed to postpone for 6 months principal and interest payments for SMEs that borrowed less than THB 100 million in loans. 	<ul style="list-style-type: none"> • Eased debt classification criteria to allow SMEs and general customers who are bank debtors to undergo debt restructuring without any stain on their credit history.

Economy	Private Sector Initiatives	Regulatory Forbearance
Vietnam	<ul style="list-style-type: none"> Directed credit institutions to offer restructuring and waiving/reduction of interest and fees for loans affected by the epidemic (amounting to about VND 285 trillion). 	<ul style="list-style-type: none"> Directed credit institutions to support customers by maintaining debt classifications.
Brunei Darussalam	<ul style="list-style-type: none"> (AMBD and the Brunei Association of Banks (BAB)) agreed on following measures effective from Apr 1, 2020: <ul style="list-style-type: none"> Support for the business sector in the form of six months' deferment on principal repayment of financing/loans for the following sectors: (1) tourism; (2) hospitality/event management; (3) restaurant (food and beverage); (4) air transportation. Extend the deferment to food and medical supplies importers to support the high cash flow requirements. Waive all bank fees and charges, except for third party charges, related to trade and payment transactions for companies in these sectors for six months. Waive online local interbank transfer fees and charges for 6 months for all customers to encourage social distancing. 	
Cambodia	<ul style="list-style-type: none"> Relaxed and delayed principal and interest payment, in particular, for owners of hotels, guesthouses and other tourism-related sectors (case by case basis). Revised Special Financing Programme of USD 50 million through Agriculture and Rural Development Bank, including: <ul style="list-style-type: none"> reducing the interest rate for working capital from 6 percent to 5 percent and for investment capital from 6.5 percent to 5.5 percent without any fee; adjusting the maximum loan term from 5 years to 7 years while keeping a maximum of 2 years for working capital; refraining from covering borrowing customers who refinance under this special program; Allowing SMEs that have not yet officially registered to apply for credit by completing the registration requirements within one month after receiving the loan. Announced USD 100 million co-financing program between the SME Bank and financial institutions by expanding coverage and adjusting the following credit conditions: <ul style="list-style-type: none"> allowing loan restructuring; continuing to disallow borrowing clients who refinance from participating in this promotional program. allowing a gradual repayment period of up to 12 months in equity and interest; adjusting the loan term from 4 years to 7 years by allowing the Private Finance Initiative to self-assess the credit period for working capital and working capital loans; extending the scope of credit coverage to enterprises in the medical device manufacturing and pharmaceutical industries. 	<ul style="list-style-type: none"> Reduced Capital Conservation Buffer (CCB) to 1.25 percent of risk-weighted assets (RWA).
Myanmar	<ul style="list-style-type: none"> Announced that borrowers will be allowed to delay repayments to microfinance and other non-bank financial institutions. 	
Lao PDR	<ul style="list-style-type: none"> Announced measures to encourage commercial banks and financial institutions to provide payment accommodations to borrowers affected by the pandemic: 	<ul style="list-style-type: none"> Reduced Capital Conservation Buffer (CCB) to 1.25 percent of risk-weighted assets (RWA).

Economy	Private Sector Initiatives	Regulatory Forbearance
	<ul style="list-style-type: none">• Commercial banks and financial institutions to consider the deferment of the repayments, interest rate, and reduction of the interest rate and fee.• Provision of special loans to borrowers affected by COVID-19 to support the payment of wages and continuation of business operations• Commercial banks and financial institutions to consider restructuring the debt for those affected by the COVID-19.	

Appendix II. Stress Test Methodology

We estimate the incremental credit losses from rising risks of default and contagion of ASEAN+3 banks, via a stress test. We set January 2020 as the benchmark date and derive the total additional loss to the wider financial system from a shock to a particular bank with two separate methods.

First, we shock the probability of default (PD) of a selected bank to estimate the direct losses to its creditors. As illustrated in Appendix Figure 1, when bank A defaults, its direct creditors, B2 and B3, will immediately incur a loss to the asset (loans) side of their balance sheet equivalent to a proportion of A's liabilities, as represented in Appendix Figure 2. Here, we assume in a hypothetical stress scenario that:

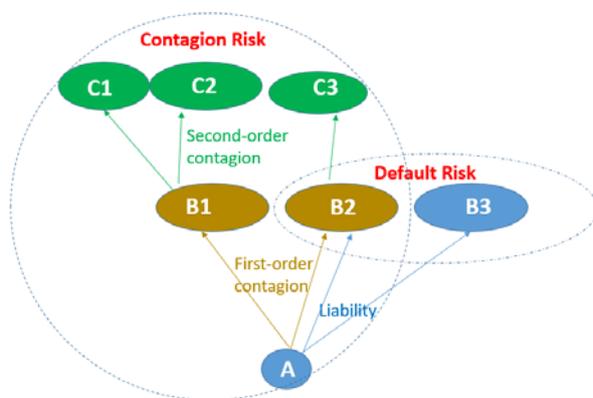
- A's default is characterized by an assumed increase in its PD by 20 basis points, the difference in creditworthiness between a typical investment-grade and a speculative grade institution ([Credit Research Initiative of the National University of Singapore, 2020](#));
- A fails to fulfil all its liabilities, that is, the sum of all the exposure at default (EAD) of its creditors; and
- A's creditors are only able to recover 40 percent of their exposures, that is, they are hit by a 60 percent loss given default (LGD) of A's obligations, consistent with the standard in CDS pricing.

The incremental expected (credit) loss (EL) arising from the shock to A's default risk is thus estimated as:

$$(1) \quad \Delta Expected Loss_{A's\ creditors} = \Delta PD_A \times LGD_{A's\ creditors} \times EAD_{A's\ creditors},$$

where $LGD = 60\%$, $\Delta PD = 0.2\%$, and $EAD = A's\ total\ liabilities$.

Appendix Figure 1. Default vs. Contagion Risk



Source: AMRO staff.

Appendix Figure 2. Institution A: Balance Sheet

Asset	Liability & Shareholder Equity
Loan	Capital
Other assets	Liabilities

Source: AMRO staff.

Next, we use the co-movements of probabilities of default (PDs) to estimate financial interconnectedness. Financial interconnectedness based on PDs reflect both balance sheet linkages and synchronous shift in market sentiment. The existing approaches for analyzing financial interconnectedness utilize either inter-bank exposures or purely market-based indicators (e.g. stock or CDS prices):

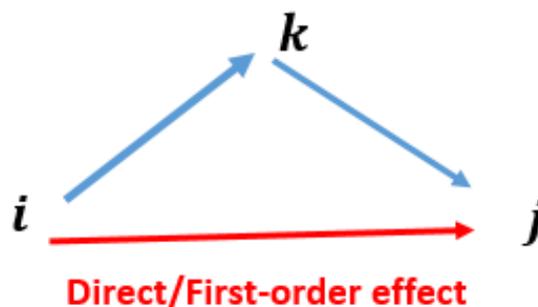
- The former captures only linkages from borrowing-lending relationships and ignores market sentiment (which proved crucial during the GFC). Moreover, this strand of research is often constrained by data availability, particularly in cross-border cases, and could thus result in incomplete network analysis.
- The latter reveals interconnectedness with market information of the underlying assets. Its efficacy rests on the extent to which the market indicators reflect financial distress timely and properly, and whether data are available for a representative set of the global financial institutions.⁷

Our proposed approach is based on a direct measure of financial distress incorporating both firm and economic fundamentals and market perceptions. This methodology combines the existing approaches that focus on either balance sheet linkages or synchronous market movements, and therefore provides a more comprehensive picture of the interconnectedness that gives rise to contagion risk. Specifically, we regress the *PD* of “risk receiver” *j* on the *PD* of “risk sender” *i*, controlling for *PDs* of all others in the sample, which could potentially “contaminate” the direct relationship between the pair, such that:

$$(2) \quad PD_j = \alpha + \beta_{j,1}PD_1 + \beta_{j,2}PD_2 + \dots + \beta_{j,i}PD_i + \dots + \beta_{j,n}PD_n + e_j,$$

where, $i, j = 1, 2, \dots, n$, such that $i \neq j$, and $n \approx 2,000$, which represents the total number of institutions in the sample. *PD* is the log-odds transformation of the original PD bounded by (0,1), and the treatment is to make the variable in the $(-\infty, +\infty)$ range and suitable for regression analysis. The estimated coefficient $\beta_{j,i}$, our interconnectedness measure, captures the extent to which the default risk of *j* co-moves with that of *i* not through any third party *k* (Appendix Figure 3).

Appendix Figure 3. Direct and First-Order Interconnectedness



Source: AMRO staff.

⁷ CDS prices are available for a few hundred financial institutions in the world, and a few dozens for the region.

This “pure” measurement removes the risk of double and triple accounting. It therefore allows us to look beyond the parties directly connected to i and quantify its higher-order interconnections with the rest of the global financial system. The identification of the coefficients is made possible through a Least Absolute Shrinkage and Selection Operator (LASSO) approach, which suppresses insignificant coefficients on high-dimensional explanatory variables to zero. Going back to the Appendix Figure 1 example:

- Suffering a credit loss from A’s default, B2 may in turn find itself in financial difficulties, and its PD could rise as a result.
- B1, which does not have a lending relationship with A, could be a victim too due to worsening market sentiment or tighter scrutiny over its business viability.
- The contagion could further propagate from B1 and B2 to the C’s, increasing their default risks, which will in turn cause losses to their creditors.
- Using again the liabilities of the affected parties along the first and second-order contagion channels, we estimate the incremental collateral damage to the wider financial system from A’s credit deterioration such that:

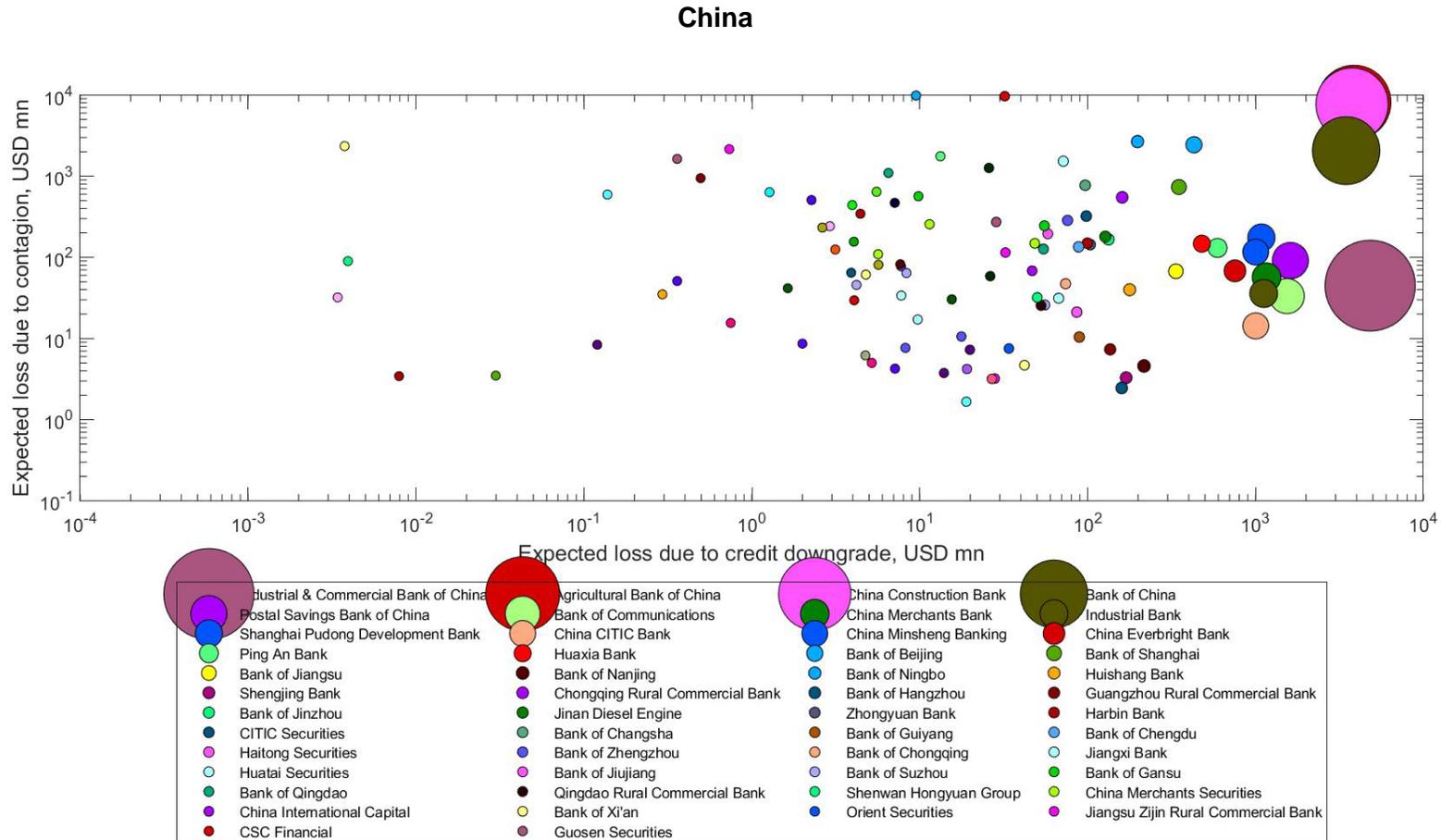
$$(3) \quad \Delta \text{Expected Collateral Damage} = \sum_{i=1}^2 \Delta EL_{\text{Creditors to FIs at A's } i\text{th order contagion}}$$

Hence, the incremental total losses to the financial system due to the specified shock may be represented as:

$$(4) \quad \Delta \text{Total Expected Loss}_{\text{Financial system}} = \Delta \text{Expected Loss}_{\text{A's creditors}} + \sum_{i=1}^2 \Delta EL_{\text{Creditors to FIs at A's } i\text{th order contagion}}$$

Appendix III. Stress Test Results for Selected Banking Systems

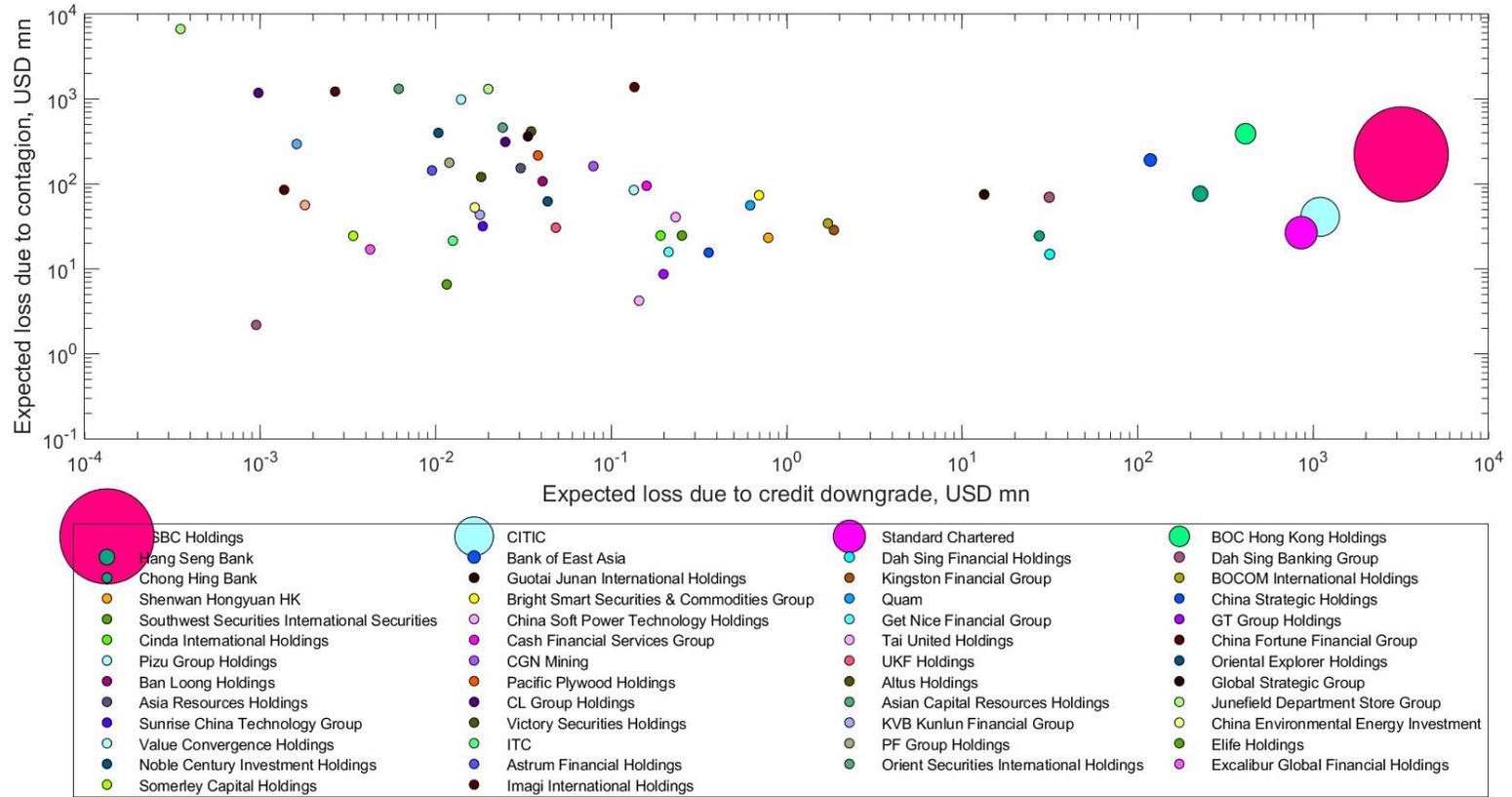
Appendix Figure 4. ASEAN+3 Banks: Expected Default Losses to Creditors and Estimated “Collateral Damage” to the Global Financial System from a 20 Basis Point Increase in PDs



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

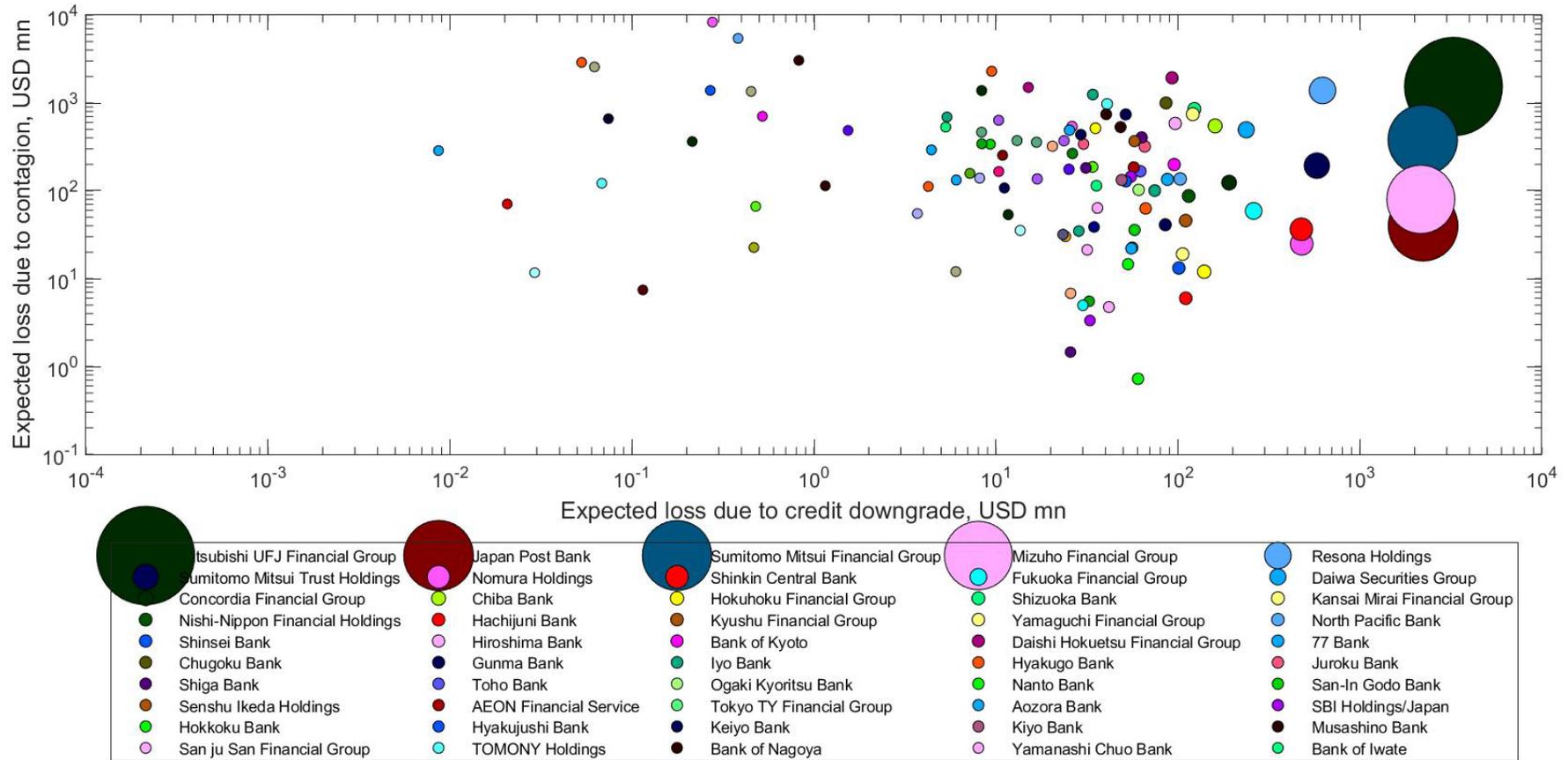
Hong Kong, China



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities. The listed entities of HSBC Holdings and Standard Chartered Bank, which proxy for their Asian subsidiaries, are included in the Hong Kong sample to reflect the location of their regional headquarters.

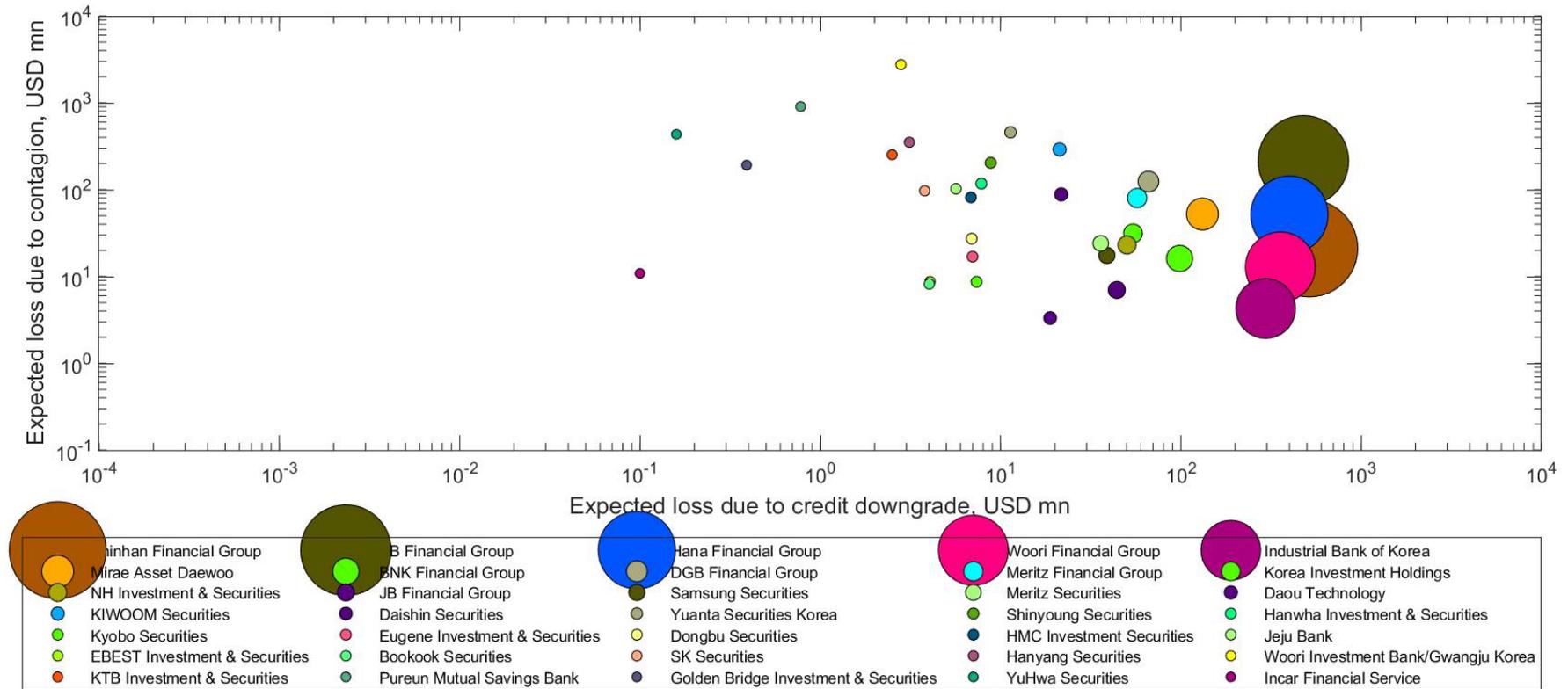
Japan



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

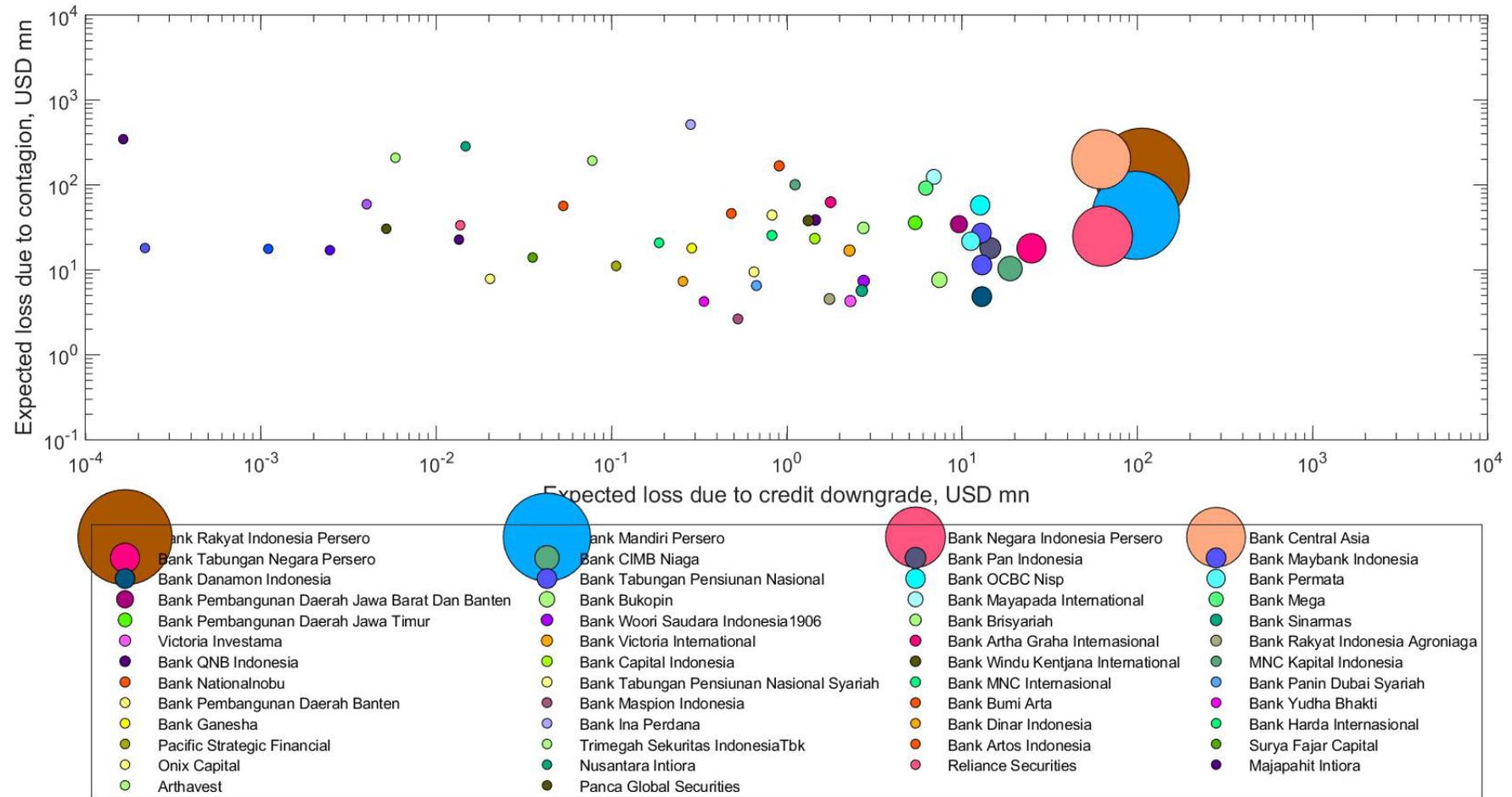
Korea



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

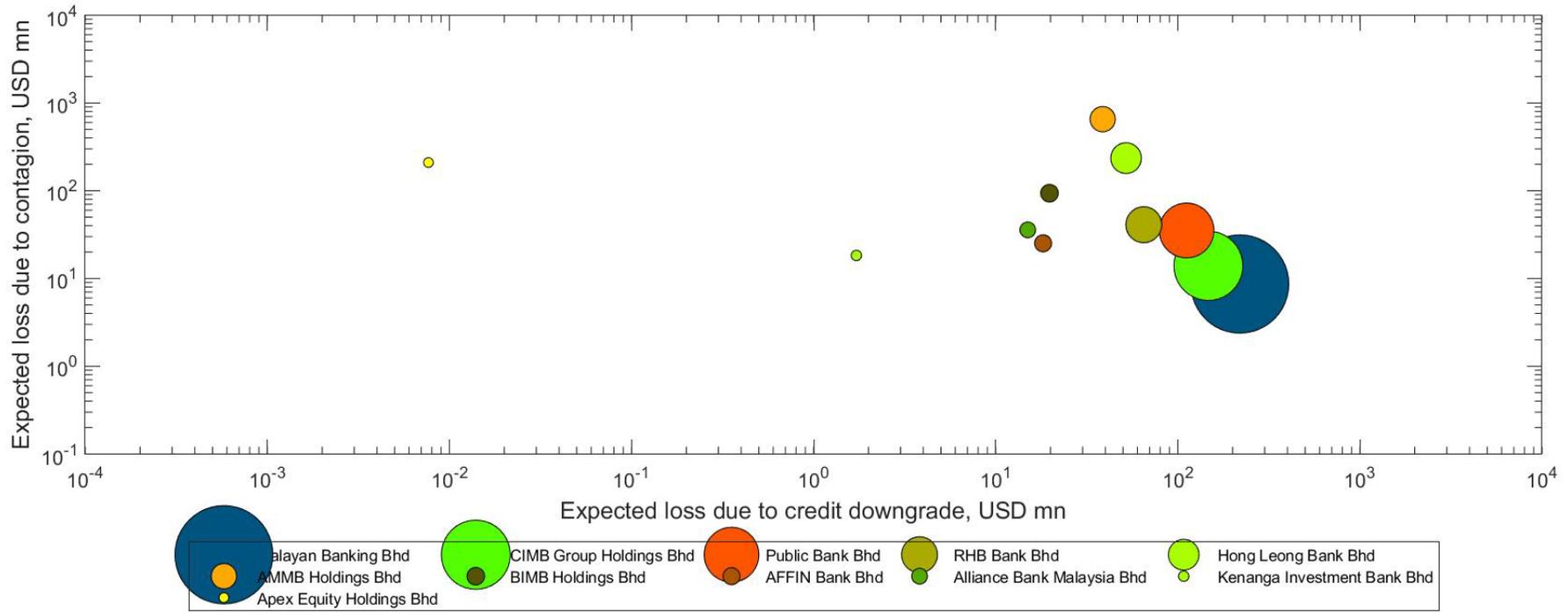
Indonesia



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

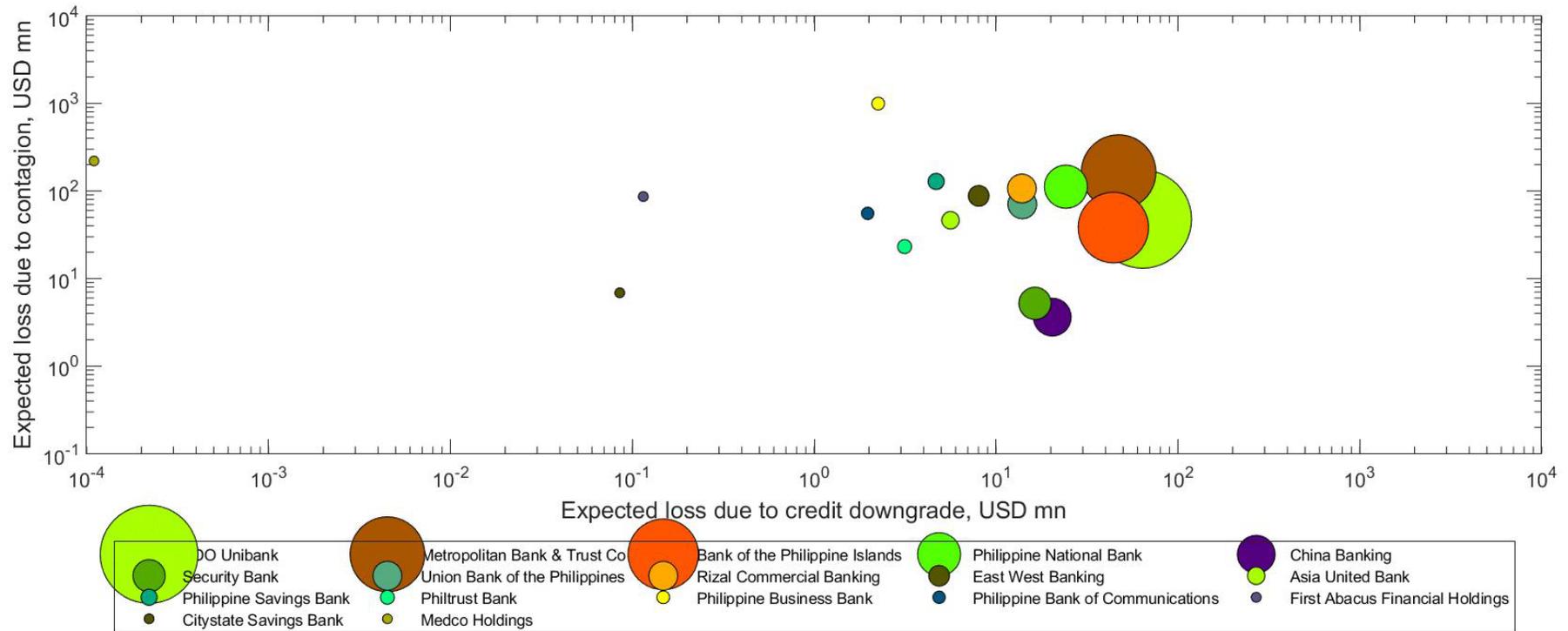
Malaysia



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

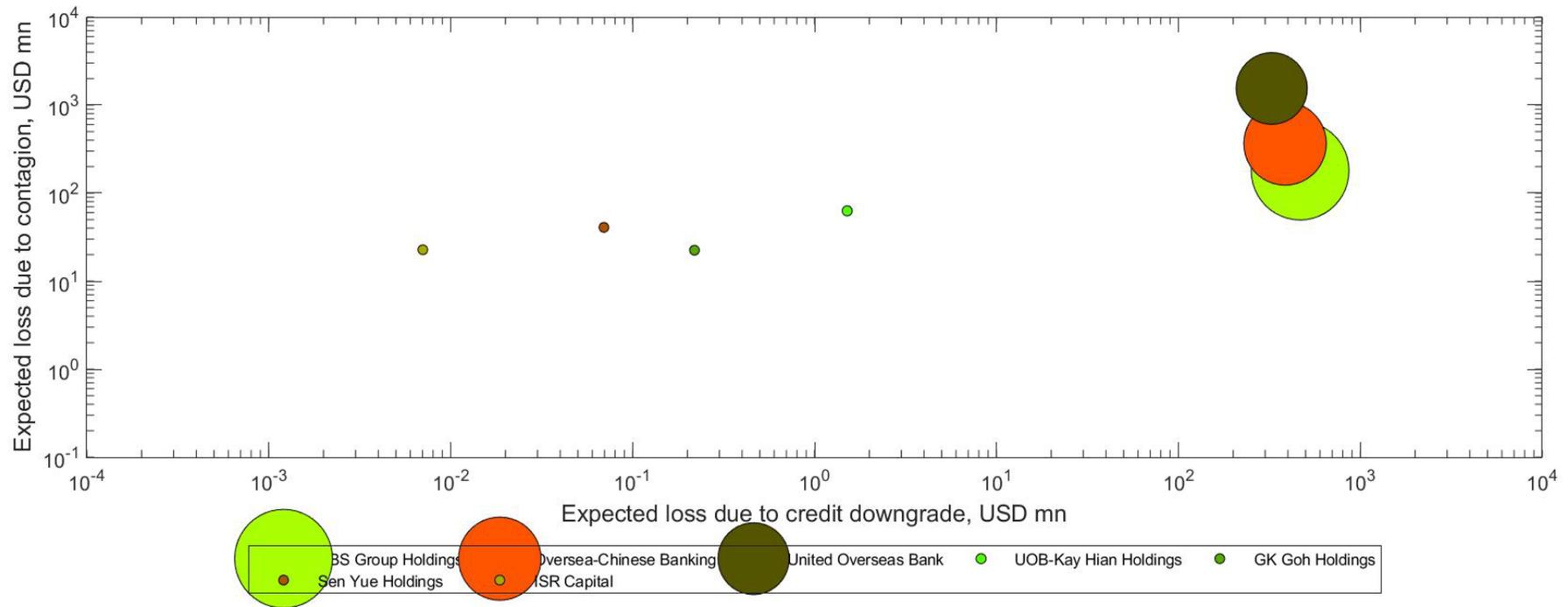
The Philippines



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

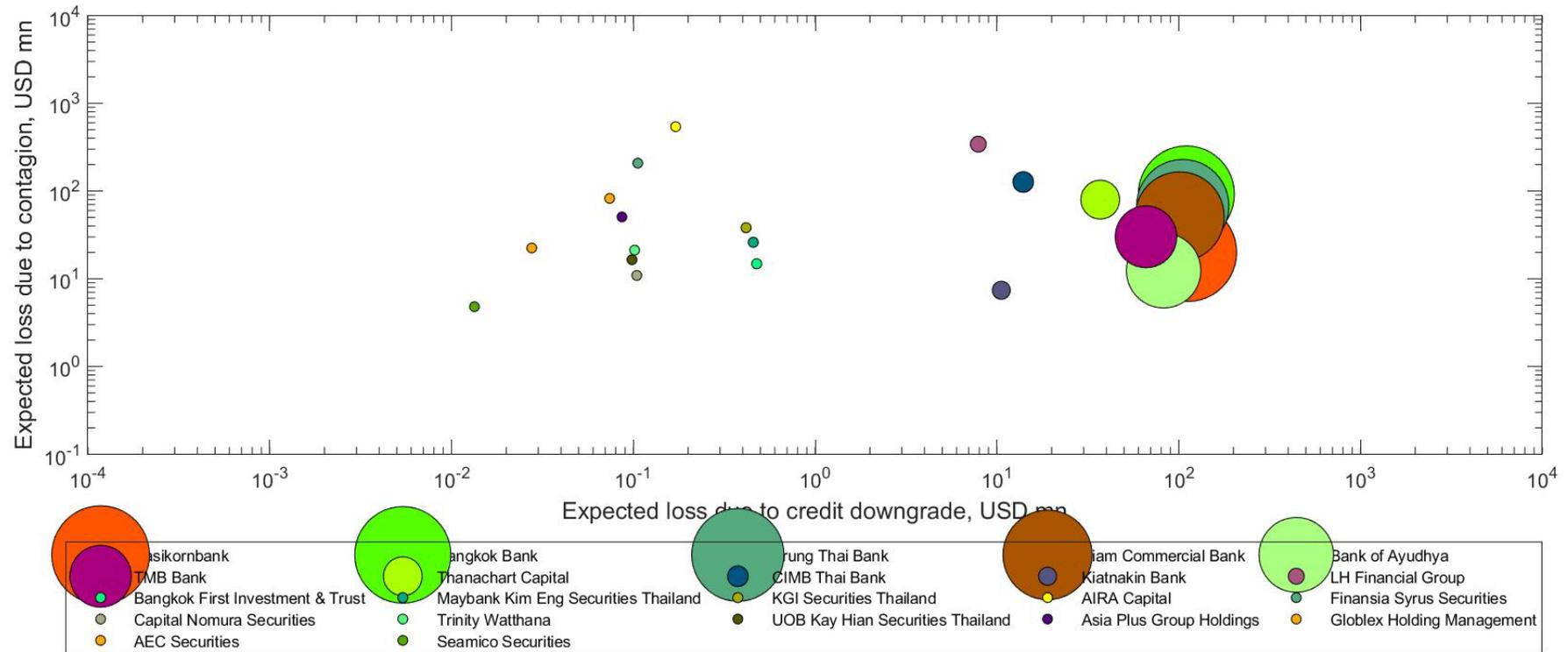
Singapore



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

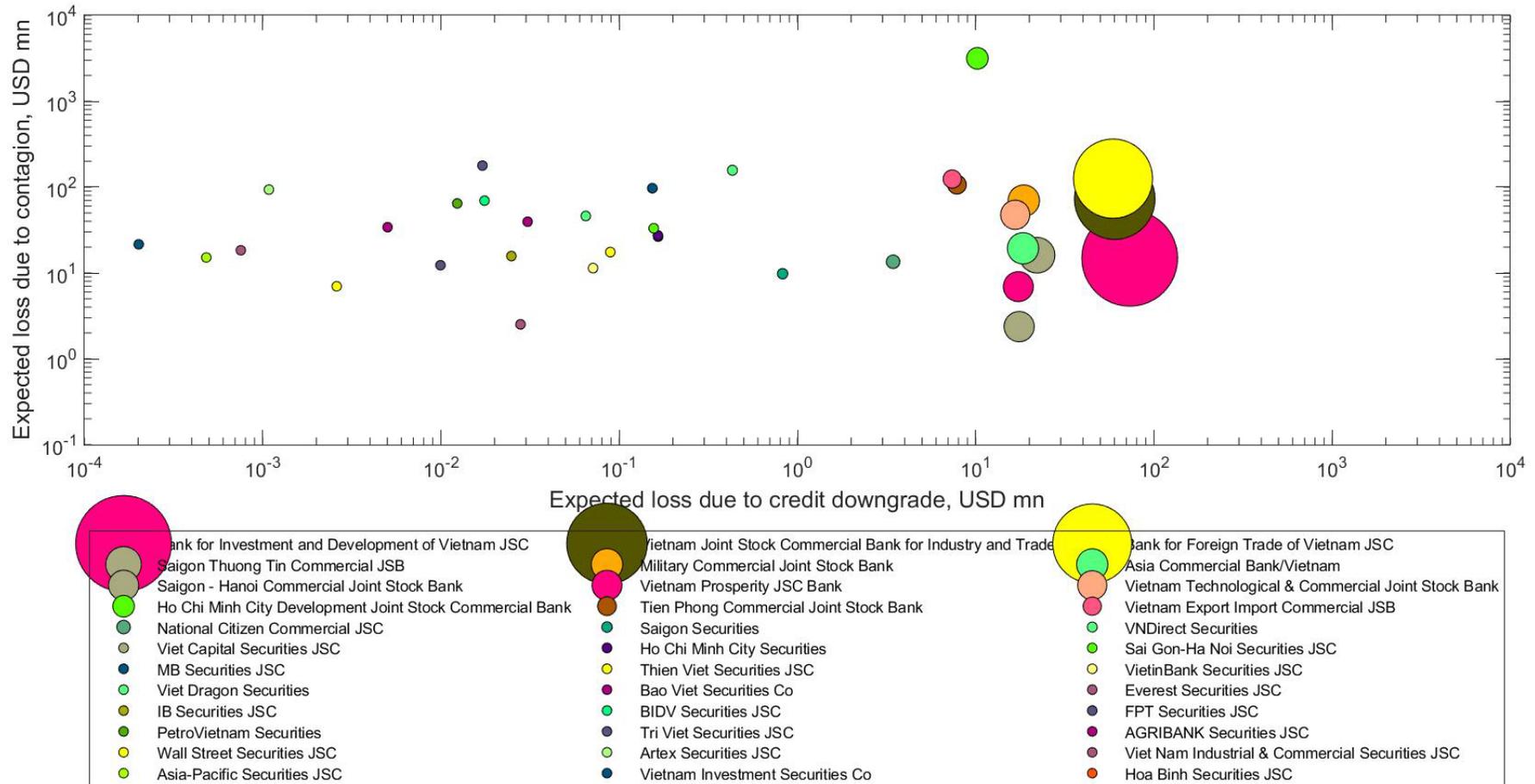
Thailand



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

Vietnam



Sources: Credit Research Initiative of the National University of Singapore; and author's calculations.

Note: $10^{-4}=0.0001$, $10^{-3}=0.001$, $10^{-2}=0.01$, $10^{-1}=0.1$, $10^0=1$, $10^1=10$, $10^2=100$, $10^3=1,000$, $10^4=10,000$. Each node represents a G-SIB/D-SIB in the region. The size of the node reflects the relative size of the bank's liabilities.

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