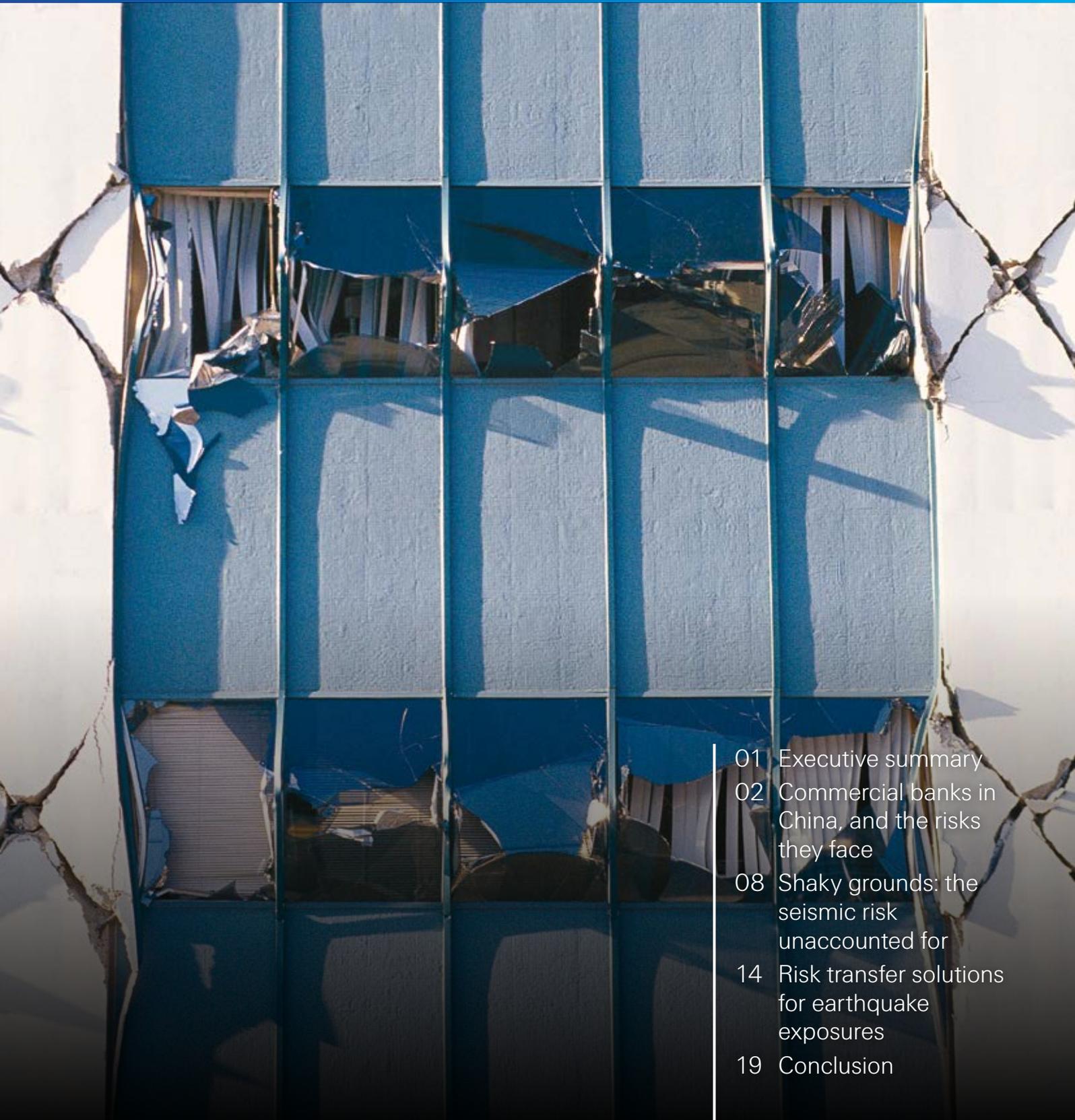


July 2018

# The earthquake protection gap facing China's commercial banks: on shaky grounds



- 01 Executive summary
- 02 Commercial banks in China, and the risks they face
- 08 Shaky grounds: the seismic risk unaccounted for
- 14 Risk transfer solutions for earthquake exposures
- 19 Conclusion

# Executive summary

Earthquakes happen frequently in China, and like all businesses, commercial banks are exposed to associated losses.

The main exposure for commercial banks is their credit assets: an earthquake can lead some borrowers to default on loans.

Around 32% of the loans from China's main commercial banks are for assets located in areas of high earthquake risk...

...and in a worst case scenario, we estimate that the banking sector could suffer losses of CNY 336 billion due to these exposures.

Currently, commercial banks have no ready response to manage the potential credit asset losses they are exposed to.

Innovative parametric insurance solutions can help close this protection gap, but much work needs to be done to promote their uptake.

Businesses in China, including commercial banks, are exposed to earthquake risk. Mainland China has a long history of earthquakes, with the northwest, southwest and north regions in particular being areas of high seismic activity. Some past disasters have resulted, tragically, in large loss of life and also heavy economic/financial losses. For banks, the exposure comes in two forms: (1) own-property damage and associated potential business interruption risk; and (2) credit risk.

Its credit assets are the source of the biggest potential losses a bank could face in the event of an earthquake. When an earthquake strikes, the losses incurred by households and businesses that have taken out loans from a bank may impair the ability of those borrowers to service their debts. For example, if the borrower is an enterprise which suffers plant or machinery damage, business interruption or loss of cargo, the firm's earning stream can be impacted, to the degree that it is not able to service its debts, and has to default on its loans. This is the credit risk that banks face.

Using data provided in their annual reports for 2016, we estimate that 32% (CNY 21.6 trillion) of the loans a sample of 17 Chinese commercial banks have issued are for business and household assets located in areas of high earthquake risk. With this aggregate exposure and assuming a normal economic outlook, using Swiss Re's catastrophe modelling tool, we simulate that the commercial banking sector's credit asset loss from a once-in-250-years earthquake event would be CNY 262 billion (0.39% of sector credit assets). We estimate the loss from a once-in-100-years earthquake would be CNY 146.5 billion (0.22% of assets) and from a once-in-50-years event, CNY 87 billion (0.13%). The model also demonstrates that in areas of advanced economic development, the losses as a proportion of total bank credit assets in that region specifically could be much higher.

Two factors affect the scale of default losses: earthquake intensity and economic environment. In down cycles, the losses resulting from an earthquake can push firms to their survival limits. The higher number of defaults in turn would mean higher losses on commercial banks' balance sheets (these appear as credit assets in a bank's balance sheet). During economic downturn, we estimate that the loss from a once-in-250-years quake would be CNY 336 billion (0.49% of sector credit assets), the loss from a once-in-100-years event would be CNY 187 billion (0.28%), and for a once-in 50-years earthquake, CNY 111 billion (0.16%).

In their role as provider of loans to businesses and households, commercial banks play a central role in the economy. To be able to function, they need to manage the different risks they face. While traditional earthquake covers are used for own-property damage, currently banks do not have a framework nor solutions in place to manage the potential credit asset losses they face should a "tail risk" (low-frequency, high-loss) event like a major earthquake strike. Recent years has seen development of innovative and tailor-made parametric (index-based) insurance products which can help narrow this protection gap.

Parametric insurance products do not compensate according to losses incurred, but pay out when a pre-defined threshold on an index is reached. In the seismic context, earthquake magnitude-based parametric products are best suited to China's regional banks located in areas where the probability of quake occurrence is high. A second approach is an earthquake-intensity based parametric product, best suited for banks with assets distributed nationwide. To promote uptake of such risk transfer solutions, the public authorities, commercial banks and insurers in China need to work together. The public sector plays an important role in the development of legal and regulatory frameworks; banks play a significant role as financial intermediaries and can help to increase awareness of earthquake risk among borrowers; and insurers can use their expertise to help banks quantify the exposures they face, and develop new solutions for their credit asset exposures.

# Commercial banks, and the risks they face

In providing loans to businesses and households...

## Keeping the economy working in a complex risk environment

Commercial banks play a central role in the workings of China's economy. Their core purpose (and utility) is to provide businesses and households with deposit and loan services, act as credit and pay intermediaries, and offer financial and credit creation services (see Table 1).

**Table 1**  
Main functions of commercial banks in China

	Description
Credit intermediary	Making full use of unallocated capital; turn short-term money into long-term funding.
Pay intermediary	Facilitate business activities such as currency settlements, collection and exchange, and deposit transfers.
Credit creation	Absorb deposits and issue loans, thereby increasing the source of funds available for economic activity.
Financial services	Provide consulting, financing agent, trust lease, collection and payment services.
Economic adjustment	Influence the investment-consumption ratio and facilitate industry restructuring through credit policy.

Source: Swiss Re Institute

...commercial banks in China play a central role in the workings of the economy.

By maintaining their ability to do business, commercial banks facilitate the normal operation of the financial system and economic growth. Maintaining their ability to operate includes, among others, managing the different risks they face. In broad terms, banks need to contend with four main categories of risk: credit, market, operational and liquidity risk. As the economy develops, the risk variables in these categories also change and become ever more complex.

The main loss exposure facing commercial banks is credit risk.

## Credit risk

The main type of credit risk is when a borrower (enterprise or household) fails to adhere to loan contract repayment terms. When a default occurs, a bank suffers loss of principal and also interest. Loans appear as credit assets on the balance sheet, and loan defaults impair the financial strength and resilience of a commercial bank. In China, loans account for close to 50% of commercial sector assets,<sup>1</sup> meaning potential for significant losses. Table 2 summarises credit risks.

**Table 2**  
Credit risks for commercial banks

	Description
Default risk	Loans are the largest source of credit risk for commercial banks. The risk of default for an enterprise or individual debtor includes failure to meet payment obligations and breach of a contractual agreement.
Exposure risk	The balance of outstanding debt in an uncertain future.
Recovery risk	The risk of recovery depends on the type of default, the existence and type of security or collateral, and the context at the time of the default.

Source: Swiss Re Institute

<sup>1</sup> According to the China Banking Regulatory Commission's (CBRC) annual report for 2016, total assets of the commercial bank sector were CNY 232.3 trillion by the year end, of which loans were CNY 112.06 trillion, (48.2% of the total). See <http://zhuanti.cbrc.gov.cn/subject/subject/nianbao2016/1.pdf>

They also face market risks,...

### Market risk

Market risk takes different forms, foremost of which is interest rate risk. Changes in interest rates create earnings uncertainty by affecting the market value of a bank's assets and liabilities. Another form of market risk is exchange rate risk. When a bank holds foreign currency, it can suffer losses due to adverse exchange rate movements during the holding period. Banks are also exposed to changes in prices for capital market securities and commodities.

**Table 3**  
Market risks for commercial banks

	Description
Interest rate risk	The sensitivity of net assets and earnings to changes in interest rates. Includes maturity mismatch, yield curve risk, benchmark risk, option risk.
Exchange rate risk	The risk of losses due to adverse changes in exchange rates during the holding period of foreign currencies.
Capital market risk	The risk that the price of capital market securities such as stocks and bonds fluctuates.
Commodity price risk	Bank holdings of physical products, such as agricultural goods, crude oil and precious metals, are at risk of adverse price changes due to various factors. Holding of futures also pose risk if the eventual settlement price of an asset is lower than the price specified in the futures contract.

Source: Swiss Re Institute

...operational risks, in particular business continuity...

### Operational risk

Operational risk arises from potential direct and indirect losses due to weaknesses in internal procedures and operations, personnel and system failures, and external events (including natural catastrophes). For example, losses can come from fraud (internal and external), a breakdown in employment and/or customer relationships, damage to tangible assets and systems failure leading to disruption in execution, delivery and transaction processes (business interruption).

**Table 4**  
Main operational risks for commercial banks

	Description
Internal fraud	Intentional default, improper acquisition or avoidance of regulatory, legal or corporate policy actions.
External fraud	The loss caused by a third party's intentional breach, improper or circumvention of the law.
Employment relationship	Personal injury loss according to legal provisions of employment, health or safety, and in respect of a discrimination lawsuit or claim.
Customer relationship	Errors in transactions with customers or losses caused by product design.
Damage to own tangible assets	Loss or damage to tangible assets caused by natural disasters or other events.
Business interruption and system failure	Loss caused by interruption of business process or system failure.
Execution, delivery and trading	The losses caused by the failure of the transaction process and from a breakdown in the relationship with a counterparty/supplier.

Source: Swiss Re Institute

...and liquidity risks.

### Liquidity risk

Banks must maintain enough liquidity to be able to respond to off-balance sheet volatility and to fund business development. Financial stability is dependent on banks being able to meet their debt obligations without incurring large losses. When a bank is able to obtain the required funds to do so at a reasonable cost within a short period of time, it is seen as having sufficient liquidity.

China has a long history of major earthquake disasters, including the one that, according to *sigma* records, resulted in the largest loss of life.

On average, there are 37 earthquakes of magnitude 5 or above in China each year.

### Earthquake risk in China: an ever-present threat

Of the different natural perils, earthquakes can be the most destructive, both in terms of loss of life and property damage. China has suffered many earthquake disasters over the years including the one that resulted in the largest loss of life from a single seismic event since 1970.<sup>2</sup> That happened in Tangshan in 1976, when 255 000 people died. And in terms of economic damage, the earthquake in Wenchuan in Sichuan Province in 2008 resulted in losses of USD 142 billion in 2017 prices, the second-highest ever on *sigma* records.<sup>3</sup>

According to data from the China Earthquake Network Centre, since 1970 there have been 1774 earthquakes of magnitude 5.0 and above in China, on average 37 such magnitude events each year. And since 1970, in total there have been 46 single earthquakes of magnitude 7.0 or above. Table 5 lists the major earthquakes that have occurred in mainland China since 1970.

**Table 5**  
Major earthquakes in China, 1970–2016\*

Year	Region	Magnitude (Ms)	Number of victims	Economic losses** (in USD 100 million)
5 Jan 1970	Yunnan	7.8	10 000	NA
10 May 1974	Yunnan	7.1	20 000	NA
4 Feb 1975	Haicheng, Liaoning	7.3	2 041	NA
<b>28 Jul 1976</b>	<b>Tangshan, Hebei</b>	<b>7.1</b>	<b>255 000</b>	<b>241</b>
6 Nov 1988	Lancang, Yunnan	7.4	730	11.4
3 Feb 1996	Lijiang, Yunnan	6.9	322	7.9
<b>12 May 2008</b>	<b>Wenchuan, Sichuan</b>	<b>8.2</b>	<b>87 449</b>	<b>1 481</b>
13 Apr 2010	Yushu, Qinghai	7.3	2 968	5.6
7 Sep 2012	Guizhou, Yunnan	5.7	81	10.7
20 Apr 2013	Ya'an, Sichuan	7.0	198	71
21 Jul 2013	Gansu	6.7	95	9.9
3 Aug 2014	Ludian, Yunnan	6.6	731	52

Note: \*Major earthquake = magnitude 7.5 or more, on the surface-wave magnitude (Ms) scale as used by the China Earthquake Administration, or number of victims >10 000 people, or economic losses >USD 500 million; \*\*Economic losses are inflated to 2017 prices.

Source: China Earthquake Data Center, Swiss Re Institute *sigma* database

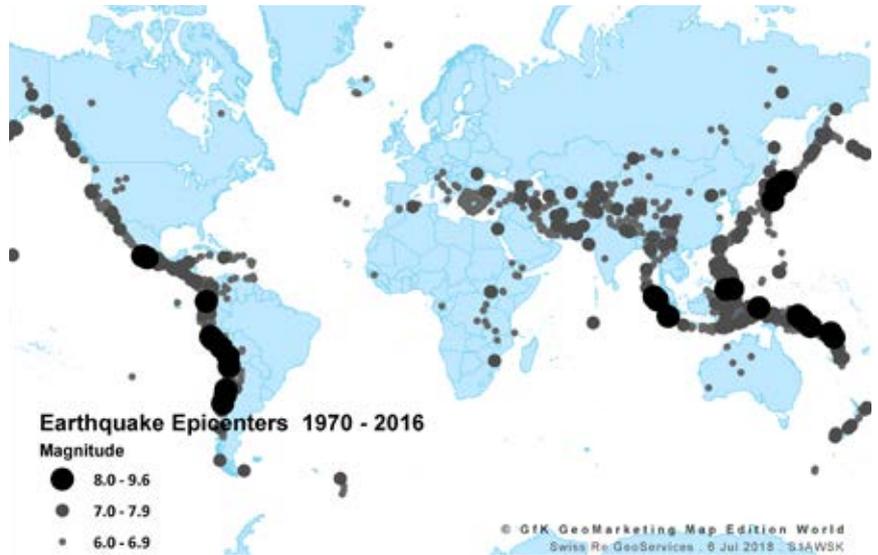
Globally, there are three main regions of high-intensity seismic activity.

Swiss Re's natural hazard risk assessment tool CatNet™ shows that globally, the epicenter of high-intensity seismic events occur mainly in three regions. The Pacific Rim, Eurasia and the sea mountain range distributed across the Pacific, Atlantic and Indian Oceans, known as the Ridge Area.

<sup>2</sup> According to *sigma* records, which go back to 1970.

<sup>3</sup> The earthquake and resulting tsunami in Japan in 2011 tops the list of most economically devastating seismic event on *sigma* records. Economic losses were USD 228.55 billion (2016 prices).

**Figure 1**  
Epicenters of major earthquakes since 1970

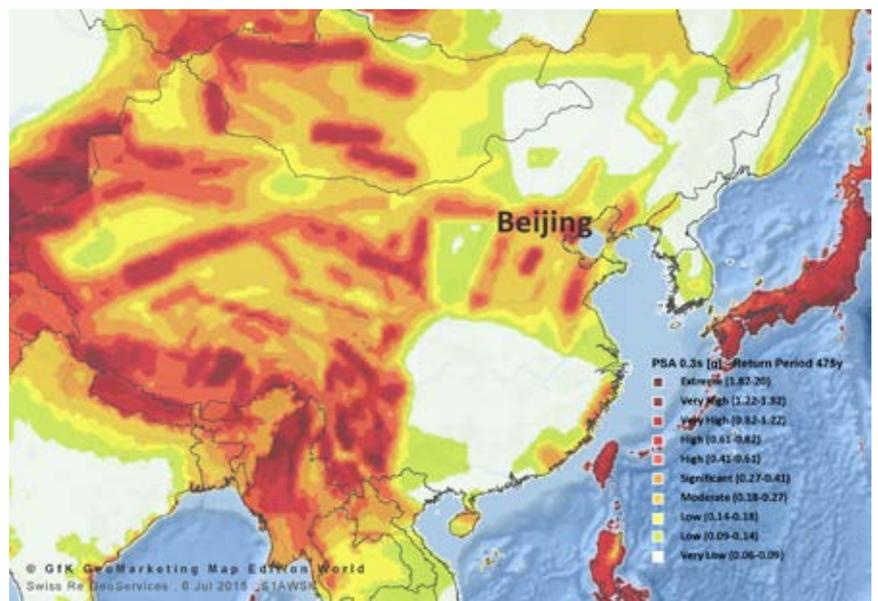


Source: Swiss Re CatNet™

In mainland China, the major seismic zones are in the north, northwest and southwest.

China sits between the Pacific Rim and the Eurasian seismic belts, with the mainland pushed northeast by the Indian Plate. At the same time, subduction by the Pacific Plate has resulted in northwest China being an area of high quake frequency. According to Swiss Re’s CatNet™, the areas of high earthquake risks are concentrated in the north, northwest and southwest of China (see Figure 2), including regions such as the Beijing-Tianjin-Hebei urban economic agglomeration. The government’s Earthquake Prevention and Mitigation Plan (2016-2020) prepared by the China Earthquake Administration states that during the “Thirteenth Five-Year Plan” period, western China is susceptible to earthquakes of magnitude 7 and above, and eastern regions to quakes of magnitude 6 or higher. And certain key economic centres, such as along the “One Belt One Road” route, the Beijing-Tianjin-Hebei region, the Yangtze River Economic Belt, and some urban agglomerations, are all exposed to earthquakes of magnitude 7 and above. These regions include important infrastructure assets and scientific research facilities. A major seismic event in these regions could result in very large social and economic losses.

**Figure 2**  
Major seismic zones in China



Source: Swiss Re CatNet™

Commercial banks are exposed to own-property losses resulting from earthquakes.

But the biggest source of potential losses are their credit assets.

The losses suffered due to an earthquake can impair a borrower's ability to service debts, potentially leading to default on loans.

In China, commercial banks can be mandated to take part in social rebuild programmes, which can also lead to credit asset losses on the balance sheet.

### How do earthquakes impact commercial banks' risk profile?

Given the frequent occurrence of earthquakes in China, it follows that commercial banks are exposed to potential own-property losses, at the very least. The China Banking Regulatory Commission's (CBRC) operational risk management framework for commercial banks does reference external events (including natural disasters) and their impact on the physical assets of a bank, and the importance of maintaining business continuity. In 2011, the CBRC issued "Guidelines for the Continuity Regulation of Commercial Banks",<sup>4</sup> These require banks to reduce or eliminate the impact of interruptions on important operations due to abnormalities in information systems services, leading to quick return to normal business and maintenance of public confidence. The events that lead to the suspension of key businesses referred to in the guidance include failure in IT systems, disruption to external services, man-made damage and fallout from natural disasters.

It is not just in terms of operational risk, however, that earthquakes can inflict losses. Of the risk categories facing commercial banks, earthquakes should also be considered as a variable of credit risk. When an earthquake strikes, the losses incurred by households and businesses that have taken out a loan from a bank, may impair the ability of those borrowers to service their debts. For example, if a borrower is an enterprise which suffers plant or machinery damage, business interruption or loss of cargo, the firm's earning stream may be impacted, to the degree that it is not able to service its debts, and has to default on its bank loans.

As populations and urbanisation increase, more borrowers and higher concentration of property assets are exposed to seismic events. This increases the credit risk exposure of commercial banks, in that many business and households could default on their loans on account of the losses inflicted by a disaster, leading to accumulation of losses on a bank's balance sheet. Further, if the earthquake wreaks widespread destruction, local economic activity could be stagnant for a long time. In this case, even borrowing firms that experience no direct property losses could be impacted, the lack of economic activity draining their financial resources to the extent that they too may default on loans. Experience from California shows that earthquakes can lead to a significant increase in bank loan default rates. For example in 1994, after a magnitude 6.7 earthquake hit Northridge, California, alongside the effect of liberalisation of interest rate across the US, the default ratio on small business loans rose to 9% from 4.4%, equivalent to around USD 400 million in absolute terms.<sup>5</sup>

There is another credit risk consideration that banks in China need to consider. They can be mandated to participate in socially-oriented rebuilding initiatives after a disaster.<sup>6</sup> For example, the government can introduce financial support policies after an earthquake which banks must adopt, such as a preferential interest rate policy for borrowers, or an easy credit policy (see *Collective financial rescue: the Wenchuan experience*). Such policies are designed to help rebuild communities, but they can also indirectly impair a bank's balance sheet.

<sup>4</sup> Notice of the CBRC on the regulation of business continuity of commercial banks, CBRC (2011) No.104.

<sup>5</sup> Estimates based on information from the US Small Business Administration, at <https://www.sba.gov/>

<sup>6</sup> The People's Bank of China and the CBRC decided to implement a special financial policy in affected areas. For more information, please visit: [http://www.gov.cn/jrzq/2008-05/20/content\\_983967.htm](http://www.gov.cn/jrzq/2008-05/20/content_983967.htm)

After the Wenchuan earthquake, banks were to give favourable treatment to affected provinces and cities...

...including writing off debts that borrowers not could pay...

...and to reduce interest rates on personal housing loans.

### **Collective financial rescue: the Wenchuan experience**

After the Wenchuan earthquake in 2008, the People's Bank of China (PBC) and the CBRC issued a directive for the restoration of preferential financial services to severely affected provinces and cities such as Sichuan, Gansu, Shaanxi, Chongqing and Yunnan. According to the notice, financial institutions were to take account of the difficulties of people and enterprises in affected areas, and those unable to repay loans were not to be penalized. Defaulters were not to be given bad records, and were to continue to be able to access disaster relief credit support.

The CBRC issued an urgent notice that financial institutions were to write-off non-performing loans (NPLs) caused by the earthquake. In accordance with the provisions of the "Measures for the Administration of Bad Debts Write-offs of Financial Enterprises (2008 revision)", banks were to cancel debts that borrowers could not repay because of the earthquake, and also debt that could not be serviced even after payment of insurance compensation or guarantees.

The PBC, CBRC, China Securities Regulatory Commission (CSRC) and China Insurance Regulatory Commission (CIRC) issued "Opinions on Financial Support and Service Measures for Post-Wenchuan Earthquake Rebuilding" on 6 August 2008, encouraging financial institutions to support resettlement and rehabilitation projects in those places designated as priority areas. The government encouraged banks to give preferential treatment to residential property and affordable housing projects in affected areas. The interest rate on personal housing loans in earthquake-stricken areas was to be 40% below the PBC's benchmark rate, and the minimum down payment ratio was reduced to 10% from 30-50%. Banks were also encouraged to issue farmers with low interest rate loans to help them rebuild and repair homes.

# Shaky grounds: the seismic risk unaccounted for

## Underestimating the threat

Commercial banks in China have little formal process in place to manage their credit asset exposure to earthquake risks.

The risk that earthquakes pose is often underplayed, even by people living in high-risk areas.<sup>7</sup> This assertion is mirrored by a survey of risk managers in commercial banks in China we undertook for this report. The survey of four random commercial banks (two state-owned, a joint-stock bank and a regional bank, to represent the different bank types in China) finds that these banks think of and manage their exposure to earthquakes in the context of operational risk and business continuity. The survey also finds that the banks have little, if anything, in place to manage their credit risk exposures to “low-frequency, high-loss” tail events like an earthquake, even though these exposures are the source of the biggest potential losses.

**Figure 3**  
Survey findings

Question	State-owned bank A	State-owned bank B	Joint-stock bank C	Regional bank D
What types of risk do you have?	Credit risk, market risk, operational risk, liquidity risk, reputational risk, legal risk etc.			
In what areas can earthquakes impact the balance sheet?	Assets: credit assets Liabilities: deposit management level, fixed assets			
Do you consider the impact of earthquake disasters in risk management measures?	Yes. In terms of operational risk. Advanced measuring methods are used to analyse the whole impact of the external shock.	No. The main thing is that it is impossible to measure and estimate earthquake risk.	All included in operational risk; Business continuity management also involved.	Considered in operational risk, through emergency contingency plans.
Does post-earthquake relief policy impact banking business?	Yes, it has influence, but only to branches in affected regions. The impact mainly refers to branch performance, not credit assets, which are distributed nationally.		It will partially affect asset quality.	Yes, it has influence and the specific situation is related to scale and area.
If economic centres and earthquakes overlap, will it affect your business?	Very large impact and stress tests are carried out. But specific effects are difficult to quantify. Only broad impact considered in advanced preparations.	It has a big impact, but there will be a national bailout in special circumstances.	The impact will be large, but as there has been no such situation, it has not been taken in consideration.	It will only affect some branches.
How big is the impact on different scale banks?	It has an impact on national bank branches, but the overall impact is modest. The impact on regional banks could be very large.			

Source: Swiss Re Institute

Globally, there has been a move to increase capital adequacy requirements so that banks can cover the financial risks they face...

Given the central role commercial banks play in keeping the economy working, it is crucial they are also well equipped to manage the different risks they face. To this end, over the last decade regulatory bodies around the world have implemented new capital adequacy requirements to ensure that banks have sufficient financial capacity to cover the risks they carry on their balance sheets. The motivation for the more-stringent regulation was the financial crisis of 2007/08, and the global recession that ensued as a result of the banking sector being wholly under-equipped to cope independently with its accumulated exposures.

<sup>7</sup> *Lessons from recent major earthquakes*, Swiss Re, January 2012.

...and China is in line with international standards on this front.

In November 2010, the G-20 approved the Basel III regulation drafted by the Basel Committee. The measure established a unified global standard for banking capital requirements which all member states were obliged to implement from 2013, and be fully compliant with by 2019. Basel III has raised the minimum requirements for capital and liquidity in international banking significantly. On 1 January 2013, the CBRC began implementation of the “Administrative Measures for the Capital of Commercial Banks,” (hereafter referred to as *Measures for Capital*) fully absorbing the regulatory capital requirements of Basel III.<sup>8</sup> The move will bring China into line with international financial regulation standards and help build the risk resilience of its banking sector, enabling commercial banks to better serve the real economy. After full implementation, the capital adequacy ratio requirement for systemically important banks and non-systemically important banks in China will be 11.5% and 10.5% of a bank’s risk-weighted credit exposures, respectively. Banks are required to comply with the new regulatory requirements by the end of 2018.

The regulatory guidance in China on the operational risk environment for commercial banks does reference the impact of external events on property assets and business continuity.

The risk thinking of banks tends to be guided by the external regulatory framework. The operational risk management framework for commercial banks in China does reference external events and their impact on banks’ physical assets, and the importance of maintaining business continuity. In 2011, the CBRC issued “Guidelines for the Continuity Regulation of Commercial Banks”.<sup>9</sup> These require banks to reduce or eliminate the impact of interruptions on important business operations due to failure in IT systems, disruption to external services, man-made damage and fallout from natural disasters. As the above survey findings suggest normally banks in China do have a process in place to manage and minimise the operational losses that could result from an earthquake.

Like the international benchmark, however, there is no mention of the credit risk that banks face due to earthquakes.

For credit risk assessment, however, the *Measures for Capital* make no mention of the potential impact an earthquake could have on the financial status of a commercial bank. Like Basel III, for credit risk the focus is on the ratings of borrowers, historic probability of default, asset classification, market value and stock volatility, while also encouraging banks to assess credit risks in different ways based on their own business environment and internal management. In our view, guidance on or mention of catastrophe exposures in regulations would help build more awareness of the issue.

<sup>8</sup> For full transcript of the *Administrative Measures for the Capital of Commercial Banks*, see <http://en.pkulaw.cn/display.aspx?cgid=176745&lib=law>

<sup>9</sup> Notice of the CBRC on the regulation of business continuity of commercial banks, CBRC (2011) No.104.

## Shaky grounds: the seismic risk unaccounted for

With no known insurance solutions for default risk in operation, the absolute losses for the modelled credit assets are assumed to represent the protection gap.

We estimated the size of credit asset portfolios...

### Quantifying the earthquake-associated credit risk protection gap

In Swiss Re terminology, the protection gap is the difference between the total economic losses that result from a disaster event such as an earthquake, and the amount of those losses covered by insurance. In the context of earthquake credit risk, with no known insurance solutions for default risk in place in the Chinese market, this study assumes the actual size of potential loan defaults to be the earthquake protection gap on commercial banks' credit assets.

#### Commercial bank credit asset distribution and size

We used data provided in the 2016 annual reports of 17 sample banks (a mixture of large commercial and joint-stock banks) to quantify the absolute amount of credit assets of China's commercial banks. We took the banks' "total loans and advances" as proxy for their credit assets. The sum of the loans and advances of the sample banks was CNY 67.9 trillion (see Table 6). According to the CRBC, at the end of 2016, total loans from *all* commercial banks in China was CNY 86.7 trillion. The aggregate 17 sample banks' loans thus accounted for 78.3% of all loans nationwide, a robust representation of the commercial bank sector overall.

**Table 6**

Combined credit assets of 17 sample banks by region, 2016 (CNY billion)

	Yangtze River Delta	Central	Western	Bohai Economic Ring	Pearl River Delta	Northeast China	Headquarters	Overseas	Total
Sub-total of sample large commercial banks	11220	5105	7836	7292	7709	2441	1640	4956	48200
Sub-total of sample joint-stock banks	5062	2208	2538	3970	2891	778	2020	228	19695
Total	16282	7313	10374	11262	10600	3219	3660	5184	67895

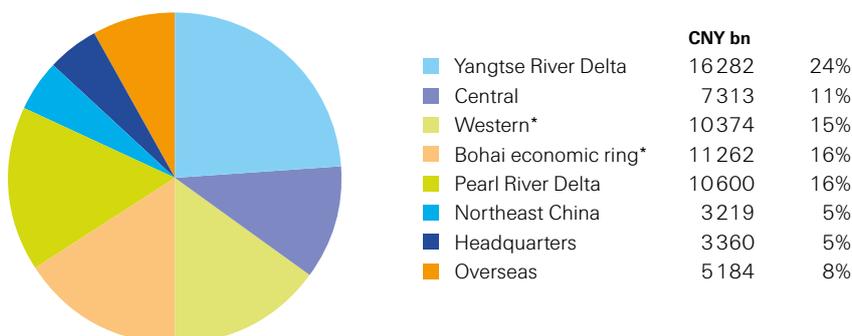
Source: Annual reports, Swiss Re Institute

...and their distribution using banks' annual reports.

The annual reports also detail the geographical distribution of the sample banks' credit asset exposures. Based on this information, Figure 4 shows the aggregate spread of the credit assets across different regions.

**Figure 4**

Distribution of 17 sample banks' credit assets by region, 2016



\*The western region and the Bohai sea area regions are high earthquake-risk areas, according to the China Earthquake Administration and Swiss Re CatNet™

Source: Annual reports, Swiss Re Institute

Around 32% of loans are for assets in areas where risk of earthquakes is high.

Notably, as Table 7 shows, loans in areas of high seismic activity account for about 32% of total value of the credit assets.

**Table 7**

Proportion of 17 sample banks' credit assets in high-earthquake risk areas, 2016

	Total credit assets (CNY billion)	Credit assets in high earthquake-risk areas (CNY billion)	Proportion of credit assets in high earthquake-risk areas
Sub-total of sample large commercial banks	48200	15128	31.40%
Sub-total of sample joint-stock banks	19695	6507	33.04%
Total of sample 17 banks	67895	21635	31.87%

Source: Annual reports, Swiss Re Institute

We simulated sector default scenarios using Swiss Re's catastrophe modelling tool.

### Simulating loan default loss scenarios

We used Swiss Re's seismic catastrophe modelling tool to simulate potential credit loss scenarios facing China's commercial banks. In addition to the data on the amount and distribution of bank loans, inputs for the model include:

- Reference history of earthquake occurrence in different regions, to establish a default rate curve. This is a correlation between seismic intensity in areas where credit assets are located and an increase in rate of defaults.
- A random event set already existing in the catastrophe model.

The scale of default losses is a function of earthquake intensity and prevailing economic environment.

Two main factors affect the scale of default losses: earthquake intensity and the economic environment. When the economy is in a period of strong growth, the probability of default after a disaster is lower. In down cycles, however, external events such as an earthquake can push firms including commercial banks to their survival limits, and the probability of defaults is higher. Using the catastrophe modelling tool, three economic scenarios (strong, normal and recession) were assumed and the default loss at different return periods (once-in-50-years, once-in-100-years, and once-in-250-years) calculated (see Table 8). The longest return period (once-in -250-years) represents the higher earthquake intensity.

**Table 8**

Scale of credit assets default in China under different economic environment and loss return period scenarios (CNY billion)

Status of economy	1/50-years frequency	1/100-years frequency	1/250-years frequency
Strong	63	106	188
Normal	87	146.5	262
Recession	111	187	336

Source: Swiss Re

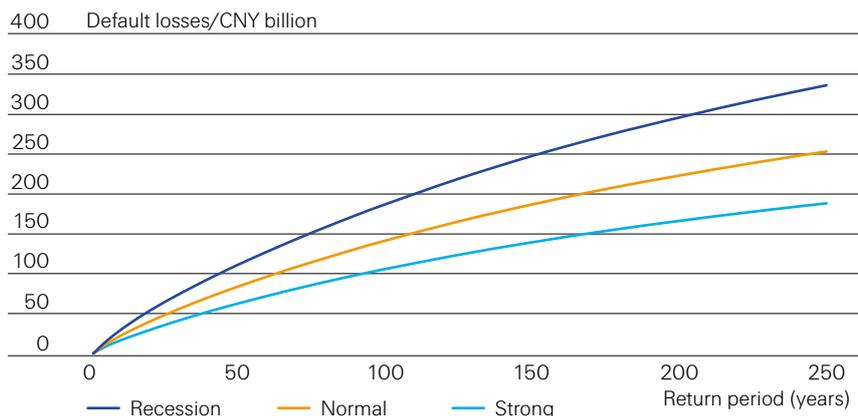
## Shaky grounds: the seismic risk unaccounted for

In a worst-case scenario, credit asset losses for China's commercial banks could amount to CNY 336 billion.

**Figure 5**

Default size of credit assets under different economic status and return period scenarios

Using the model, we estimated that in the event of a once-in-250-years earthquake in China, and if the economy is strong, the sample 17 commercial banks would be exposed to loan defaults of CNY 188 billion (0.28% of their total credit assets). In recession, the loan default loss would be CNY 336 billion, or 0.49% of the total credit assets, and under normal economic conditions, it would be CNY 262 billion (0.39%). Table 8 presents the equivalent exposures for once-in-100-years and once-in-50-years earthquake events, with the outcomes also presented in Figure 5.



Source: Swiss Re

In areas where economic development is advanced, the potential default losses could be much higher.

### Simulating loan default losses in typical earthquake scenarios, by region

For the purposes of further analysis of potential default losses, we also simulated seismic events of typical magnitude taking place in regions of high probability of earthquake occurrence and high level of economic development (eg, the Bohai Rim and western China), and areas of lower probability of earthquake occurrence but high levels of development (eg, Yangtze River Delta). The underlying assumption for all simulations was of a normal economic growth environment (see Table 9).

**Table 9**

Loan default loss of commercial banks under typical earthquake disaster scenarios (under normal circumstances)

Region	Event ID	Epicenter location	Magnitude (Ms)	Model default loss (CNY 100 million)
Beijing-Tianjin-Hebei cluster	1	5km to Beijing	7.5	6 320
	2	10km to Tianjin	7.6	5 150
	3	17km to Xiongan	7.7	1 940
Western Region	4	8km to Chengdu	6.8	780
	5	2km to Dali	7.4	360
	6	2km to Yinchuan	7.5	580
Yangtze river delta Area	7	9km to Hangzhou	6.8	1 700
	8	15km to Shanghai	6.8	5 980

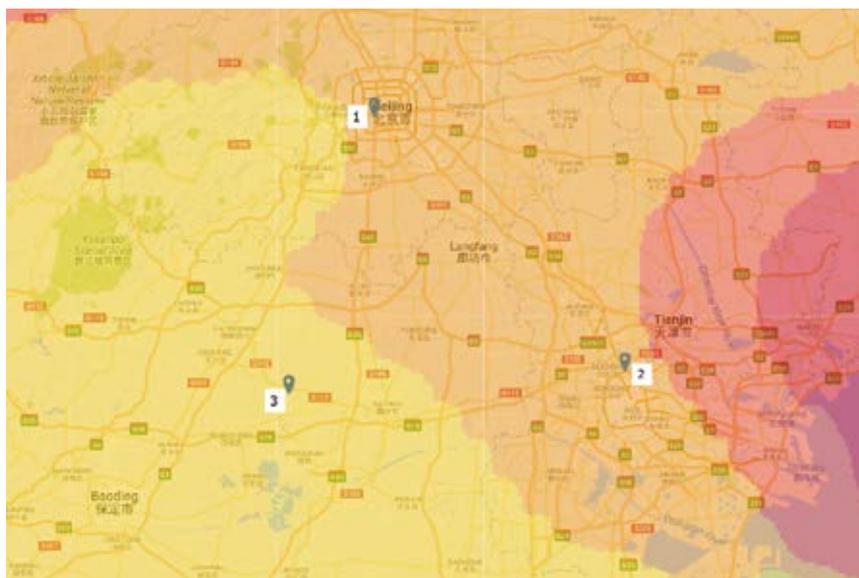
Source: Swiss Re

For example, under normal economic conditions in the Bohai Rim, modelled losses could be as much as 5.6% of commercial banks' total credit assets in the region.

A closer look at the results in Table 9 for the Beijing-Tianjin-Hebei cluster demonstrates the higher losses that could materialise if a major earthquake were to strike an area of advanced economic development. The simulation map (Figure 8) shows three earthquakes in the region with magnitudes ranging from 7–8.

- Event 1: According to the model, if a magnitude 7.5 earthquake struck around 5 km outside of Beijing, the estimated loan default loss would be of CNY 632 billion, accounting for 0.93% of total commercial bank credit assets nationwide (CNY 632 billion/CNY 67.9 trillion = 0.93%), and for 5.6% of the credit assets in the Bohai Rim region alone (CNY 632/CNY 11262 billion);
- Event 2: If the epicenter of a magnitude 7.6 earthquake was 10km from Tianjin, the nationwide default loss for China's commercial banks would be CNY 515 billion, or 0.76% of their credit assets nationwide, and 4.9% of their assets in the Bohai Rim region alone;
- Event 3: If a magnitude 7.7 earthquake struck Xiong'an region, the loss would be significant lower at CNY 194 billion. However, the losses here could rise in the future given ambitious expansion plans for the region.<sup>10</sup>

**Figure 6**  
Seismic simulation map of the Bohai Rim (Beijing-Tianjin-Hebei cluster)



Source: Swiss Re

In the Yangtze River Delta, default losses could reach 3.7% of banks' credit assets in the region.

The potential loss outcomes for the western region showing in Table 9 are not as extreme as in the Bohai Rim. According to CatNet™, the region also has high risk of magnitude 7-8 earthquake occurrence but overall, it is less developed than the Bohai Rim. For the Yangtze River Delta, though not a quake-prone area, the level of economic development is high and so too concentration of bank credit assets. The potential loss outcomes are greater than in the western region. According to the catastrophe model, in the event of a 6.8 magnitude earthquake with its epicenter 15 km outside of Shanghai, the loss of bank credit assets would be CNY 598 billion (0.88% of total credit assets nationwide, and 3.7% of assets in the Delta).

<sup>10</sup> According to a notice issued by the CPC Central Committee and the State Council on 1 April 2017, Xiong'an will be established as national-level new district, with a large second-tier city. According to estimates, after the completion of 20 years of construction across an area of 2000 square kilometres, the population will reach 6 million and total investments CNY 4.5 trillion. The average annual investment will exceed CNY 220 billion. A large part of these will likely come from large and medium-sized commercial banks. See [http://www.xinhuanet.com/2017-04/01/c\\_1120741571.htm](http://www.xinhuanet.com/2017-04/01/c_1120741571.htm)

# Risk transfer solutions for earthquake exposures

Many mature markets have established risk transfer mechanisms for earthquake exposures.

There are traditional earthquake insurance products in the Chinese market, but these do not cover the whole range of risks that firms face.

In the case of mortgages, in some situations homeowners have incentive to default, an added risk variable facing commercial banks.

In first- and second tier cities, the value represented by rapid increases in the price of land on which houses are built is not covered by any form of insurance.

## Transferring earthquake risk

Mature markets like the US, Japan and New Zealand have risk transfer mechanisms in place to manage potential exposure to earthquake losses. In the US, according to the Insurance Information Institute's survey for 2016, only 8% of homeowners have earthquake insurance.<sup>11</sup> Even in California, where earthquake risk is highest, only about 11% of homeowners have coverage. Like in China, the biggest loss potential from earthquakes for commercial banks lies with their credit asset exposures. However, in the US most banks and mortgage lenders package and sell around 60% of their mortgage loan portfolios to government-funded agencies Fannie Mae and Freddie Mac, which further securitise and sell the portfolios to institutional investors. Through this mechanism, the default risk of the mortgage loan portfolio is borne by financial institutions such as banks, insurance companies and pension funds. With respect to corporate loans, on the other hand, many small businesses do not purchase earthquake insurance. Here the risk is carried by a company's owner and lender. Larger companies have more sophisticated risk management strategies, including the purchase of earthquake insurance.

In China, earthquake insurance penetration is low.<sup>12</sup> There have been recent initiatives by the government to promote uptake of traditional residential earthquake insurance (see *China's urban and rural residential earthquake catastrophe pool*). Uptake of traditional property covers by borrowers can partly mitigate the credit risk losses facing commercial banks, and lenders should consider whether such insurance is in place as part of their assessment of new loan applications. Even if insurance is in place, however, this does not mean all the risks are covered. In the case of enterprise loans, businesses in an earthquake-hit area can suffer income losses due to interruption to operations, a reduction in output due to factory damage, stock loss or transport blockages. Some of these losses are covered by property insurance, but indirect losses due to economic slowdown and client base shrinkage for example, are not. When a firm experiences such losses, it may also default on its loans, which translates into financial loss for banks.

With respect to homeowner mortgages, it is not just inability to pay that lead borrowers to default: in some situations, borrowers may have incentive to default. In China, the most common residential structure is called a department building (an apartment block). If an earthquake leads to collapse of a department building, or severe structural damage to the degree that the building is uninhabitable, its owners have high incentive to default on their mortgages because the property is of no value to them anymore. In this event, the bank can take ownership of the property but even that will register as a loss on the balance sheet because of the depreciated value of the building.

Another consideration is that where earthquake insurance is in place, the sum insured is only for the replacement value (construction costs) of a department building. In first- and second-tier cities, however, the construction cost represents just 5~20% of the market value of buildings. Most of the value lies in the land on which buildings sit. In many areas, the price of land has been rising faster than the price of buildings themselves, and this value is not covered by any form of insurance. In such cases, department building owners may default as the pay out from the property insurance covers only a small portion of the real loss.

<sup>11</sup> *Earthquake insurance and risk*, Insurance Information Institute, June 2017: [https://www.iii.org/article/background-on-earthquake-insurance-and-risk#Recent developments](https://www.iii.org/article/background-on-earthquake-insurance-and-risk#Recent%20developments)

<sup>12</sup> According to *sigma* 3/2017 - World insurance in 2016: the China growth engine steams ahead, non-life penetration in China was 1.8% in 2016.

Sometimes property value depreciates to below the level of outstanding loans. In these cases, incentive to default is high.

There have also been cases where borrowers choose to default as the value of their property depreciates to such an extent that it is worth less than the value of outstanding loans. A similar scenario would occur if a big earthquake affects the value of land. In such cases, even if banks repossess a property, it would still be difficult to be fully compensated for the financial losses on the original loan because of the depreciation in property and land values.

The government has established an earthquake catastrophe insurance pool for homeowners to be able to access insurance.

#### **China's urban and rural residential earthquake catastrophe pool**

On 16 April 2015, China's government set up the urban and rural residential earthquake catastrophe insurance pool ('earthquake pool') as a means to encourage uptake of homeowner earthquake insurance. There are currently 45 insurers in the pool. Eligibility criteria includes an insurer having maintained a solvency ratio of more than 150% for three years, having a strong branch network and also strong underwriting capabilities.

The cover provided by the Pool is for property damage resulting from an earthquake of magnitude 4.7 or more, and/or intensity of VI or more.

The earthquake insurance product sold by the Pool has been developed by the China Insurance Association (IAC). It provides cover for physical damage to residential building property resulting from an earthquake of magnitude 4.7 or higher, and/or intensity of VI or higher, these parameters set by the National Earthquake Administration. Losses resulting from vibrations, tsunamis, fires, volcanic eruptions, explosions, subsidence, ground fissures, mudslides and landslides due to the earthquake are also covered. Losses on internal decorations and household contents are not compensated for. The maximum sum insured for steel structures, steel-concrete structures and mixed-structure residential houses is CNY 1 million. The maximum coverage for masonry-wood residential structures is CNY 0.1 million, and CNY 0.06 million for other material structures.

Participating insurers sell the cover and share the premiums generated according to their respective stakes in the Pool.

The business model is that all participating insurers sell the product through their respective distribution channels. The split of overall premiums received among the insurers is based on their individual shares of the Pool. In the event of an earthquake that triggers payouts the co-insurers share the loss on the principle of 'risk sharing, grading burden'. The members of the earthquake pool are responsible for providing a unified claims service.

## Risk transfer solutions for earthquake exposures

To date, there have been no insurance solutions for China's commercial banking credit assets earthquake exposures.

This can change with the development of parametric insurance products.

Earthquake-magnitude parametric products are better suited to regional banks in earthquake-prone areas.

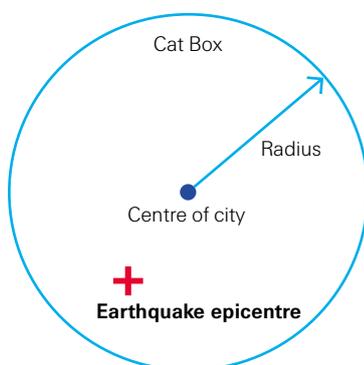
### Innovative earthquake insurance products

As stated, the credit risk that banks face due to earthquake cannot be 100% mitigated by traditional property insurance covers. Recent years have seen development of innovative parametric insurance products which could be tailor-made to allow banks in China to transfer their earthquake credit risk exposures.

An insurance payout from a parametric or index-based product is triggered when a pre-defined threshold on an index is reached, rather than being based on actual losses incurred after an event. In the case of earthquakes, the index characterizes the scale of the shock, such as earthquake magnitude or seismic intensity. The development of this type of product has been enabled by advances in technology and (digital) data analytics. Parametric insurance simplifies the process of claim handling and provides transparency on payout amounts.

Magnitude-based parametric products would be best suited to regional banks in China located in areas where the probability of earthquake occurrence is high. For example, if the credit assets of a bank are concentrated in a city and surrounding area, a circle of pre-defined radius (eg, 200 kilometres) with a city at the centre can be drawn. This is called the Cat Box (shapes other than circles can be used, depending on best fit for the topography of the area). If an earthquake occurs, the epicenter of which is within the Cat Box area, the insurer is obliged to compensate the insured banks for potential default losses with a pre-defined payment amount. A weakness in this solution is basis risk, namely that the insurance payout does not match the real default loss experience of a bank.

**Figure 7**  
Cat Box framework



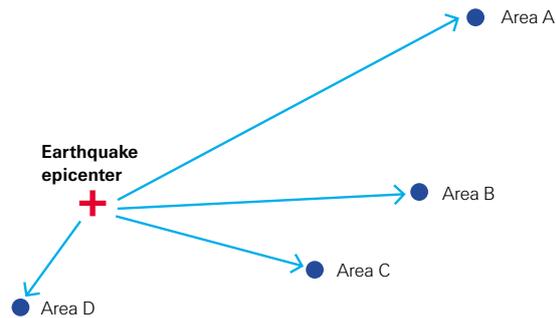
Magnitude	Claims (CNY million)
<6	0
6-7	20
7-8	50
>=8	100

Source: Swiss Re and Swiss Re Institute

Earthquake intensity index-based products better serve the needs of commercial banks with credit asset exposures nationwide.

The second solution is an earthquake intensity based parametric product. This would be best suited for commercial banks with assets nationwide. In case of an earthquake, the payout is defined according to the value of the asset, as well as the intensity of ground vibrations felt/measured at the location of that asset, the latter usually a variable of its distance to the epicenter. For example, as in Figure 8, a bank has credit assets in areas A, B, C, and D. If an earthquake with 6.5 magnitude strikes, and the epicenter is as where showing, the payout for assets in location A, furthest away from the epicenter would be CNY 5 million. The payments for assets at locations B, C and D are greater, given their closer proximity to the epicenter.

**Figure 8**  
Earthquake intensity product framework



Intensity	Claims (CNY million)			
	A	B	C	D
<6	0	0	0	0
6-7	5	10	15	50
7-8	10	20	30	100
8-9	40	80	120	400
>=9	100	200	300	1000

Source: Swiss Re and Swiss Re Institute

The public sector, insurers and commercial banks need to work together to promote uptake of parametric products.

### Facilitating increased uptake of innovative solutions

There are many reasons why commercial banks in China underestimate the potential impact of earthquakes on their credit risk profile, and banks, insurers and the public authorities need to work together to bring about an effective system of reducing earthquake risk. The public sector plays an important role in the development of legal and regulatory frameworks; banks play a significant role as financial intermediaries and can help to increase awareness of earthquake risk; and insurers have expertise in risk management and product development.

- Current capital adequacy regulations for the banking sector in the *Measures for Capital* do not include separate analysis of seismic risk. The measures could be updated to require commercial banks to separately measure the capital adequacy ratio under seismic scenarios. As stated, regulators do not mandate assessment of seismic hazard in credit risk modelling. The risk management thinking of banks tends to be guided by the external regulatory framework. If the regulators were to provide such direction, consideration of earthquake and other disasters in credit asset risk assessment models would more readily become a norm.

In March 2018, the China's Banking and Insurance Regulatory Commission merged the responsibilities of the CBRC and the China Insurance Regulatory Commission (CIRC). The integration should provide a stronger regulatory and institutional basis to encourage banks to set up quantitative models for earthquake risk.

- Banks lack experience in seismic risk management. Earthquake catastrophe modelling is common place for insurers but banks lack similar quantitative tools to assess the impact of seismic events. Without models, earthquake risk remains a vague concept, difficult to quantify and price, and likewise difficult to bring to the attention of senior management and banking regulators. Further, for nationally operating banks, while it is individual bank branches that are exposed to earthquake risk, the subsequent losses are borne by the group business rather than the branch impacted. For this reason, the incentive to manage risk is often higher in regional banks in earthquake-prone areas than in national banks.

With quantification of the exposure, banks can adjust their loan issuance strategies in a timely manner. Insurers can also broaden the scope of coverage through product innovation and explore the use of new forms of insurance to transfer credit risks under the bank's seismic scenarios.

- Economic losses caused by an earthquake are usually covered by the state. It is widely assumed that the government will step in as insurer of last resort in the event of a major disaster. To date, this has often been the case. For example, the economic losses resulting from the Wenchuan earthquake in September 2008 were CNY 845.215 billion. Central and local government contributions to relief funds were CNY 80.936 billion, and the total donations from home and abroad amounted to CNY 59.469 billion. In contrast, post-disaster insurance compensation was just over CNY 2 billion (0.2% of the economic loss).

These new index-based solutions can help banks narrow the protection gap they face on their credit asset exposures.

In interviews with bank risk executives, most said banks would be vulnerable to insolvency risk if an earthquake caused a sharp rise in defaults on loan. However, they also said that the government would likely step in to maintain financial stability. The dawn of innovative index-based insurance solutions presents an opportunity for commercial banks to narrow the protection gap that they face on their credit asset exposures and lower their dependency on the (assumed) government safety net.

# Conclusion

Commercial banks in China have significant credit risks exposures

China has regions of high seismic activity, including in areas of economic development such as the Beijing-Tianjin-Hebei cluster. Through their branch networks in these areas, commercial banks own property assets that are exposed to seismic risk events. Many banks include traditional earthquake insurance as part of their operational risk management strategies. However, the main source of vulnerability to earthquakes are the banks' credit assets, not their own property interests. The risks are the loans that commercial banks issue to businesses and households (mortgages). Where borrowers suffer damage due to an event like an earthquake, they may not be able to adhere to loan repayment terms, and default.

In a worst case scenario, sector losses could amount to CNY 336 billion.

Using Swiss Re's catastrophe modelling tool, we estimate the credit asset exposure to earthquake risk of China's commercial banking sector based on distribution of loans by location of a sample of 17 banks. Under normal economic conditions, we estimate the potential overall credit asset loss for the sector resulting from a once-in-250-years earthquake event to be CNY 262 billion (0.39% of total credit assets). The loss from a once-in-100-years earthquake would be CNY 146.5 billion (0.22% of total credit assets), and from a once-in-50 years event it would be CNY 87 billion (0.13% of total credit assets). During economic downturn, the credit asset loss from a once-in-250-years quake would be CNY 336 billion (0.49%), the loss from a once-in-100-years event would be CNY 187 billion (0.28%), and for a once-in 50-years earthquake, CNY 111 billion (0.16%).

Today there are no insurance covers for these exposures.

Today banks in China have no risk management response in place for credit risk losses caused by earthquake. In the interests of sustainable economic growth, this needs to change. Through their loan and deposit services, commercial banks play a central role in facilitating the normal operation of the country's financial system and economy. Absent of insurance, some banks could face crippling default losses if a tail risk (low frequency, large loss) event like a major earthquake were to occur. If the quake were to strike an area where development is advanced, the default losses would mount and could have far-reaching social and economic ramifications.

Innovative parametric insurance products can help narrow this credit risk protection gap facing commercial banks.

There is a tendency for commercial banks in China to underestimate their exposure to earthquake risk. There are many reasons for this. For instance, regulations (local and international) do not include seismic or other natural hazard scenarios as variables to consider in credit asset risk modelling. This is one example of how closer collaboration among stakeholders could help narrow the protection gap. The public sector plays an important role in the development of legal frameworks, and regulators could begin to offer guidance on how to include disaster scenarios in credit asset risk assessment models, such that the concept itself becomes a mind-set norm. Another area of collaboration is for insurers to support risk managers in banks overcome their lack of experience of seismic risk management. Banks do not have the tools to model disaster scenarios that are common place in the insurance sector. Insurers can use their expertise to help banks quantify the exposures they face, and can also develop new solutions for banks' credit asset exposures. The development of parametric insurance products in recent years offers an opportunity to cover the credit risks that commercial banks are currently exposed to.

**Published by**

Swiss Re Institute  
Swiss Re Management Ltd.  
P.O. Box  
8022 Zurich  
Switzerland

Telephone +41 43 285 2551  
Email [sigma@swissre.com](mailto:sigma@swissre.com)

**Armonk Office**

175 King Street  
Armonk, NY 10504

Telephone +1 914 828 8000

**Hong Kong Office**

18 Harbour Road, Wanchai  
Central Plaza, 61st Floor  
Hong Kong, SAR

Telephone + 852 25 82 5644

**Authors**

Dr. Li Xing  
Telephone +86 10 6563 8657

Cindy Zhang  
Telephone +86 10 6563 8636

**Editor**

Paul Ronke  
Telephone +41 43 285 2660

**Managing editors**

Jerome Jean Haegeli  
Swiss Re Group Chief Economist

Dan Ryan  
Head of Research at Swiss Re Institute

The author is particularly grateful to the following colleagues for their contribution to this report: Leon Tang, Tony Chen, Xin Dai, Wenwen Ying, Ariel Cheng, Andy Tran, Thomas Holzheu and students from the University of International Business and Economics: Li Jiahao and Li Zhirui.

If you need Chinese version, please contact [Cindy\\_Zhang@swissre.com](mailto:Cindy_Zhang@swissre.com).

The editorial deadline for this report was 15 April 2018.

Online version of the report may contains update information.

Graphic design and production:  
Corporate Real Estate & Logistics / Media Production, Zurich

© 2018  
Swiss Re  
All rights reserved.

The entire content of this study is subject to copyright with all rights reserved. The information may be used for private or internal purposes, provided that any copyright or other proprietary notices are not removed. Electronic reuse of the data published in publication is prohibited. Reproduction in whole or in part or use for any public purpose is permitted only with the prior written and if the source reference 'Swiss Re Institute, April 2018, The earthquake insurance protection gap facing China's commercial banks: on shaky grounds' is indicated. Courtesy copies are appreciated.

Although all the information used in this study was taken from reliable sources, Swiss Re does not accept any responsibility for the accuracy or comprehensiveness of the information given or forward looking statements made. The information provided and forward-looking statements made are for informational purposes only and in no way constitute or should be taken to reflect Swiss Re's position, in particular in relation to any ongoing or future dispute. In no event shall Swiss Re be liable for any loss or damage arising in connection with the use of this information and readers are cautioned not to place undue reliance on forward-looking statements. Swiss Re undertakes no obligation to publicly revise or update any forward-looking statements, whether as a result of new information, future events or otherwise.

Order no: 1507490\_18\_EN

Swiss Re Management Ltd.  
Swiss Re Institute  
Mythenquai 50/60  
P.O. Box  
8022 Zurich  
Switzerland

Telephone + 41 43 285 2551  
Fax +41 43 282 0075  
[sigma@swissre.com](mailto:sigma@swissre.com)  
[institute.swissre.com](http://institute.swissre.com)