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Impact of Extreme Weather Episodes on the Philippine Banking Sector: Evidence Using Branch-Level Supervisory Data

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Abstract

There is a growing recognition that natural disasters and severe weather-related events pose risks that can potentially and unintentionally affect the stability of the banking system. This study confirms the effects of severe weather conditions on the banking sector performance. The paper first constructs a regional quarterly rainfall damage index (RDI) based on data from weather stations across the country. A regional branch-level database from supervisory reports is then compiled based on 11,000 banking units from the BSP's Branch Regional Information System (BRIS). Using Dynamic Panel Generalized Method of Moments (GMM), the results show deterioration in branch-level loan growth and loan quality as savings and time deposit liabilities contract and non-performing loans surge following extreme rainfall events from 2014 to 2018. These are particularly evident in regions most vulnerable to extreme rainfall episodes and to branches of universal and commercial banks as well as of rural and cooperative banks. However, the overall negative impact on profitability eventually tapers off. These findings are robust across different specifications and alternative estimation methods such as fixed effects and Panel Vector Autoregression estimations.

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1. The context

Bolton et al (2020) highlighted that climate change poses new challenges to central banks, regulators and supervisors. However, integrating climate-related risk analysis into financial stability monitoring is particularly challenging because of the significant uncertainty associated with a physical, social and economic phenomenon that is constantly changing. These include "green swan" risks which are characterized by potentially extremely financially disruptive events that could be behind the next systemic financial crisis. Bolton et al (2020) went on to underscore that central banks have a role to play in avoiding such an outcome, but central banks alone cannot mitigate climate change. This complex collective action problem requires coordinating actions among many players including governments, the private sector, civil society and the international community.[2]

Carney (2015) explained that there are three categories of climate-related risks that may rise following discussions on climate change: (1) the physical risks associated with more frequent severe or extreme weather events and lasting environmental changes, (2) the transition risks posed by the policy and technological changes necessary to achieve a greener economy, such changes could strand carbon-intensive assets and affect the value of other financial instruments, and (3) the liability risks which come from people or businesses seeking compensation for losses they may have suffered from the physical or transition risks from climate change.

The magnitude of estimated losses due to physical and transition risks, along with the potentially rapid nature of those losses, could have a severe impact on financial institutions and broader financial markets. The move towards a greener economy could impact not only energy companies but also those that produce cars, ships and planes, or use a lot of energy to make raw materials like steel and cement.

While the physical risks from climate change have been discussed for many years, transition risks are a relatively new category. Indeed, the increase in frequency and severity of damaging floods, droughts, fires, and hurricanes, as well as encroaching sea level rise, can lead

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[2] These may include climate mitigation policies such as carbon pricing, the integration of sustainability into financial practices and accounting frameworks, the search for appropriate policy mixes, and the development of new financial mechanisms at the international level.

to destabilizing losses for banks, other financial intermediaries and even insurance companies with direct and indirect exposure to different affected industries and assets.

During the past decade, extreme weather events, particularly super typhoons and intense monsoon rains, had hit the Philippines with such regularity. In particular, Typhoon Yolanda (Haiyan), which caused an estimated P571.1 billion[3] of damages and losses, along with thousands of casualties, easily comes to mind. The unprecedented scale and magnitude of the impact of Typhoon Yolanda has made the Philippine government take a second look at the appropriateness of its disaster-resiliency and rehabilitation programs that can mitigate the impact of such extreme weather events on the economy and on the welfare of the people. Apart from the cost in terms of forgone output, productivity losses as well as fiscal and external sustainability, extreme weather events also pose risks to the soundness of financial institutions and stability of the overall financial system (FSAP forthcoming). Moreover, the ability of financial institutions to mobilize finance in mitigating disaster impact and preventing further macroeconomic spillovers is crucially relevant (Brei et al, 2019). From a policy perspective, understanding the role of access to finance after a natural calamity is equally important.

Hence, discussions on estimates of extreme weather episodes, disaster-preparedness and resiliency are essential going forward.

Apart from typhoons, southwest monsoon rains (*habagat)* enhanced by nearby typhoon/tropical storms have just as much brought damage and losses as normal storms. The enhanced *habagat* can be characterized as having an intense volume of rain released over a short period of time (i.e. less than a day to a couple of days), which subsequently leads to intense flooding. In addition, these intense monsoon rains have become frequent. Aside from damage to properties, disruption in economic activity and productivity for a prolonged period has been experienced. In particular, the TS Ondoy *habagat* dumped over a month's volume of rain in just nine hours, placing twenty-three provinces and Metro Manila in a state of calamity. Based on available data, damages were estimated at PHP 11 billion. Several extreme *habagat* episodes were recorded in 2012 (Typhoon Haikui) and in 2013 (TS Maring), with estimated damages recorded at PHP3 billion and PHP689 million, respectively.

Looking at these natural disasters, assessing the impact of weather disturbance such as severe rainfall conditions on the banking sector becomes crucially insightful. However, empirical evidence remains limited. Brei et al (2019) summarized some findings in recent studies on the impact of natural disasters on banking sector. Klomp (2014) concluded that natural disasters increase the likelihood of bank defaults and that the extent of this depends on financial regulation, a country's financial and economic development, and the size and magnitude of the disaster. Keerthiratne and Tol (2016) found that firms and households fall deeper into debt after a natural disaster and this effect is stronger in poorer countries. Choudhary and Jain (2017) revealed that following the flooding in Pakistan banks disproportionately reduced credit to new and less-educated borrowers. For Collier (2014), El Niño related flooding in Peru resulted in large loan losses that caused the lender to contract credit, hindering economic recovery. In the Philippines, preliminary assessment by Campipi et al (2018) showed positive association between natural disasters and median bank deposit

[3] World Bank. 2017. "Philippines: Lessons from Yolanda," *World Bank Policy Note*.

interest rates across branches and units across the Philippines. This finding indicates that in regions seldom hit by natural disasters, the propensity to save concurs with the observed favorable bank interest rates on deposits.

Banks and related financial institutions provide credit and funds for rehabilitation, reconstruction and recovery. In a recuperation stage following a calamity, economic agents must have access to quick and unconstrained funds for smooth and immediate recovery.[4] Evidently, areas with better access to funds and have well-developed financial markets have greater chances of enduring natural disasters. In any case however, there are almost always attendant consequences with economic rippling effects or systemic repercussions—i.e. savings are redistributed and diverted to recovery efforts instead of development, insurance payments exert downward pressure on profits which can extend to relevant financial markets when left unchecked.[5] The implication is that natural disasters and weather-related events pose risks that can potentially lead to large financial losses and tightening financial conditions that can affect the stability and proper functioning of financial systems.[6] This raises the question on how and to what extent do extreme weather conditions can affect the financial system and its operations.

This study adds to the empirical literature on natural disasters and the banking sector by examining the impact of extreme weather conditions on banking sector performance using the BSP's Branch Regional Information System (BRIS). Following Brei et al's (2019) model, the study first constructs a quarterly rainfall damage index (RDI)[7] based on available rainfall statistics from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA). The estimated RDI is then used to determine the impact of extreme rainfall events on selected bank-specific variables from a panel dataset of over 92,000 banking units across the Philippines using Dynamic Panel Generalized Method of Moments (GMM) from the first quarter of 2014 to the fourth quarter of 2018.

This paper is structured in five parts. After this discussion, a brief description of the data is provided in Section 2. This is followed by a discussion of the estimation approach, results and analysis in Sections 3 and 4, while Section 5 offers some insights for policy and concludes.

2. Baseline Database

This study compiles and constructs four unique sets of databases for the Philippines on branch-level and regional banking indicators based on data from Government weather stations and supervisory reports.

Branch Regional Information System (BRIS). To undertake the analysis, data from BRIS were compiled to build a panel dataset of over 92,000 banking units (branches, head offices and units) across the country from the third quarter of 2014 to the fourth quarter of

[4] Keerthiratne and Tol (2016).
[5] Ibid.
[6] "Transition in thinking: The impact of climate change on the UK banking sector". *Prudential Regulation Authority, Bank of England.* September 2018.
[7] As cited in Brei, M., Mohan, P., and E. Strobl (2019).

2018. The BRIS is a regular monitoring tool of the BSP which started in 2010 through BSP Circular Number 613 dated 18 June 2008. The Circular requires bank head offices to submit a Report of Selected Branch Accounts on a semestral basis. However, for purposes of determining market median rates on deposits and monitoring banks that rely excessively on large, high-cost deposits/borrowings, the BSP issued Circular 848 in September 2014, requiring bank branches to submit quarterly reports on bank deposit interest rates to be included in the report of selected branch accounts. This Report generates branch- level data on selected income and balance sheet accounts, as well as published interest rates for peso deposit products including regular peso savings, kiddie savings and time deposit accounts of different tenor terms and maturities. Data from BRIS, for instance the deposit interest rates, are consolidated into a quarterly Bank Deposit Interest Rate (BDIR) report and are submitted to the BSP Monetary Board. However, it should be disclosed that in some banks, the reporting is done by major regional banks, not by branch.

Table 1. Average growth rate (%) of selected bank indicators of BRIS reporting units, by industry: 2015-2018

	Total Assets	Total Loans	Total Deposit Liabilities	Total Interest Income	Total Interest Expense	Net Interest Income	Total Net Profit	Total Net Operating Income	Ave. No. of Banking Offices per Province
Rural and Cooperative Banks									
2015	11.6	3.3	11.1	11.2	4.3	12.9	2.9	12.4	23
2016	34.7	44.8	36.4	30.3	13.3	34.2	34.1	37.0	25
2017	1.2	-5.9	6.1	-5.9	-7.4	-5.7	-8.7	-3.7	24
2018	9.3	9.2	7.8	11.3	10.1	11.6	0.9	7.3	25
Thrift Banks									
2015	13.6	19.6	15.7	14.3	13.3	14.5	5.1	11.5	24
2016	12.2	16.6	12.8	18.4	18.0	18.4	28.5	17.8	26
2017	9.2	8.2	8.0	6.3	7.5	6.1	12.1	5.3	26
2018	5.8	9.3	4.9	14.9	32.9	9.2	0.5	7.2	22
Universal and Commercial Banks									
2015	7.4	12.0	8.0	10.6	18.7	15.4	3.0	8.3	68
2016	12.7	17.4	14.3	10.5	9.1	10.9	13.8	12.0	70
2017	12.1	17.5	11.9	16.8	15.0	17.3	7.0	10.7	72
2018	11.8	14.8	9.2	25.4	54.8	17.0	9.1	14.9	48

Source: BRIS

A panel dataset was constructed covering bank branches across regions, majority of which are universal and commercial bank (UKBs) outlets located in urbanized regions with NCR and CALABARZON having the highest number of reporting units. By industry, UKBs comprise nearly 65 percent of all respondents per quarter of the period covered, while the remaining respondents are almost equally divided among rural banks (RBs) and thrift Banks (TBs) with quarterly shares ranging from 15-20 percent and 11-19 percent, respectively.

In terms of assets, UKB branches which dominate the total number of banking units are estimated to have aggregate assets ranging from P10.2 trillion to P15.3 trillion from 2014 to 2018, closely approximating the recorded industry total for the period covered. As shown in Table 1, UKBs' total asset grew considerably from 7.4 percent in 2015 to 12.7 percent in 2016 and 12.1 percent in 2017, before dipping slightly to 11.8 percent in 2018. Asset expansion was accompanied by similar improvements in loans, deposit liabilities and other income aggregates. Meanwhile, after growing robustly by double-digit rates in 2015 and 2016, both the TB and RB banking groups exhibited contraction in total assets and other income-related accounts. The aggregate assets of TBs in our dataset which ranged from P845 million to P1.2 trillion, were almost parallel to the annual industry assets except for the years 2014 and 2015, when the combined assets of the sample amounted to about 96.0 percent of the industry. Similarly, the resources held by the RBs oscillating between P144.9 million to P240.8 million annually for the years 2014 to 2018, correspond to about 72 percent to 96 percent of the industry asset for most of the period covered.

In terms of geographic reach or network, majority of the bank branches or offices are located within urbanized regions, with Metro Manila or the National Capital Region (NCR) having the highest concentration of banking units for all the years covered. Following the NCR which has over 35 percent of the total banking units in its jurisdiction, are Central Luzon and the CALABARZON regions with 10.6 percent and 13.7 percent, respectively. These two regions are also the popular locations for rural and cooperative banks, as well as thrift banks. This is in stark contrast to the Autonomous Region of Muslim Mindanao *(*ARMM), Cordillera Administrative Region (CAR) and Eastern Visayas regions, which consistently had the least number of banking offices.

Given the strong banking presence in the NCR, its contribution to the aggregate banking assets is also the biggest, especially in the case of UKBs. Average assets of UKBs operating in the NCR in 2014 and 2018 are five to ten times bigger than the average aggregate assets of those located in the ARMM, and almost three to four times the average asset of UKBs in Central Visayas, the region with the second biggest allocation or share in the average industry assets next to NCR.

Following Brei et al (2019), we analyzed the impact of rainfall on banks' lending capacity, funding sources and financial soundness. To this end, we use the conventional indicators namely total loans and deposit liabilities, non-performing loans, net profit and return on assets (ROA). Other income and expense variables (i.e. net interest income, operating income and non-interest expense) were likewise added in the fixed effects model for additional robustness checks.

Table 2. Summary statistics of major variables

Variables	No. of Observations	Mean	Std. Dev.	Min	Max
		(in M PhP)			
Total Loans	122,612	1,040.4	16,376.9	0.0	1,018,200.9
Total Deposit Liabilities	167,036	1,079.9	4,970.5		252,082.3
Non-Performing Loans	167,030	15.7	241.2	(246.9)	12,929.0
Net Profit	44,923	72.0	983.5	0.0	62,545.7
Net Income	66,654	77.0	1,281.8	0.0	111,747.0
Net Interest Expense	165,960	23.8	485.0	(240.6)	66,380.7
Total Equity	46,278	614.2	8,498.1	0.0	357,375.7
Return on Assets (in %)	45,106	0	2	-	161.7
Rainfall Damage Index	166,750	11	22	-	99.5
Regular Peso Savings Deposit	166,948	271.0	989.0	(82.0)	76,222.5
Peso Time Savings Deposit: Less than 30days maturity					
Below PhP 50,000	5,131	0.1	0.8	(49.9)	30.0
PhP 50,000- less than PhP100,000	4,842	0.7	16.5	0.0	1,110.0
PhP 100,000- less than PhP500,000	7,316	2.9	13.0	0.0	840.7
PhP 500,000- less than PhP 1 million	5,534	4.0	26.0	0.0	1,411.4
Over PhP 1 million	8,371	379.3	2,135.3	(3.0)	62,708.9
Peso Time Savings Deposit: 1 year maturity					
Below PhP 50,000	29,403	0.1	0.2	0.0	8.5
PhP 50,000- less than PhP100,000	32,107	0.2	0.3	0.0	14.4
PhP 500,000- less than PhP 1 million	29,745	2.0	3.6	0.1	420.9
Over PhP 1 million	28,711	23.1	285.4	0.1	18,373.9
Peso Time Savings Deposit: Over 1year maturity					
Below PhP 50,000	10,489	0.3	7.3	(0.0)	501.2
PhP 500,000- less than PhP 1 million	26,241	9.6	26.6	0.1	838.2
Over PhP 1 million	26,920	72.9	361.9	(0.0)	16,933.2

Source: BRIS

Table 2 provides the summary statistics of the major variables used in the analysis. The data allow us to classify deposit liabilities into regular peso savings deposit and peso time savings deposit. The peso time savings deposit is further broken down into maturity profile, such as peso time-savings deposits with less than 30days, one year and over one year, and in bucket size, such as below PhP50,000, PhP 50,000-less than PhP100,000, PhP 500,000 to less than PhP 1 million and over PhP 1 million. Moreover, total loans and non-performing loans will give us a picture of the credit and asset quality of bank portfolio during the period. The profitability structure of banking units is indicated by net profit, net income, net interest expense, total equity and return on assets, all of which recorded significant variation. In terms of rainfall damage index, we find that the average quarter has about 11 percentage point damage, but with considerable variation. In particular, the largest amount of damage witnessed over the four-year sample was nearly 99 percent.

Rainfall Data. Rainfall statistics from the 53 synoptic stations[8] of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA) were utilized as proxy for weather disturbance. These stations are spread out across the country—33 in Luzon, 12 in Visayas and 8 in Mindanao, which means that some provinces or regions are hosting multiple weather stations. However, it is possible for areas with no station to assign a weather station on the basis of the relative distance between the province and the nearest station as each of these stations have allowable reach and coverage of 30 km up to 50 km

[8] A station where observation of almost all meteorological elements are made at fixed observation times and are transmitted to the Central Office. These stations are maintained and operated by PAGASA. It is responsible for the dissemination of public weather forecasts, tropical cyclone bulletins, warnings and advisories and other related information to protect the lives and property of the general populace. *Source: PAGASA website*

radius.[9] For regions or areas with multiple data points for each quarter, only the station with the highest or the most rainfall is selected and included in the analysis.

Data show that rain distribution varies across regions (Figure 1). The average monthly rainfall data from 2014 to 2018 are negatively skewed indicating heavy rainfalls during the latter half of each year, except for 2018 where there is a slight dip for October and November (Table 3). Nevertheless, between 2014 and 2018, the mean annual rainfall in the Philippines ranged from 169.4 mm to 242.7 mm annually. Several provinces in the south-eastern part of the country such as Eastern and Northern Samar, Leyte, some parts of the Bicol region, as well as Baguio and Benguet in the North are shown to receive the greatest amount of rainfall. It must be noted that Samar and Leyte are also the same areas that were hardest hit by Typhoon Haiyan ("Yolanda").

Meanwhile, Mindanao provinces particularly South Cotabato and Zamboanga had the least amount of rain showers. These rainfall data were also aggregated by region and transformed into a rainfall damage index. Table 3 and Figure 2 provide the observed amount of monthly rainfall from 2014 to 2018. These rainfall data were also aggregated by region and transformed into a rainfall damage index.

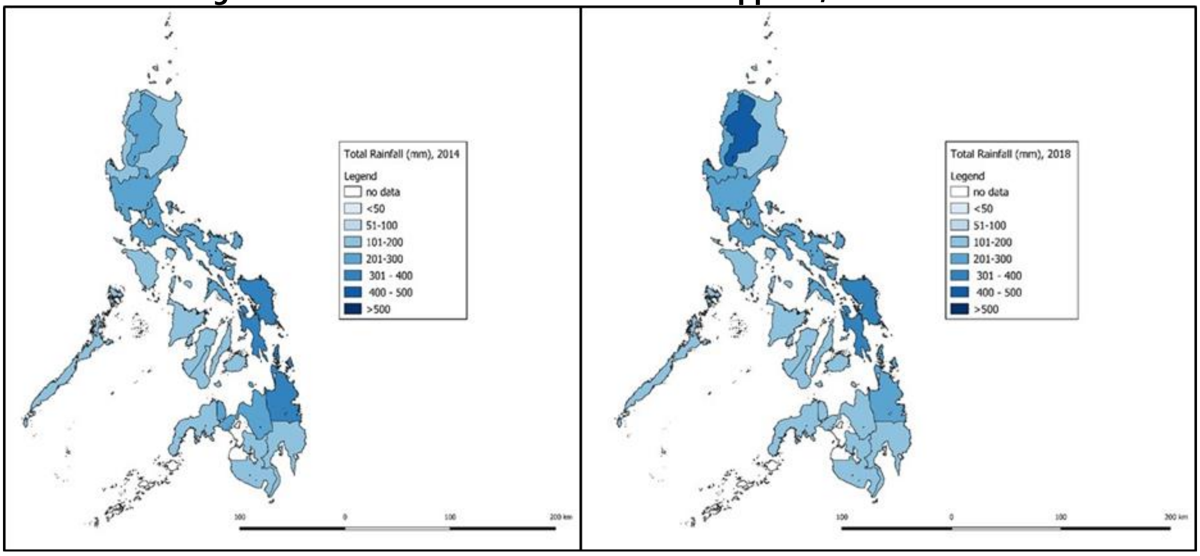
Table 3. Average monthly rainfall: 2014-2018

	Average Rainfall (in milimeters)				
	2014	2015	2016	2017	2018
JAN	245.8	172.9	85.3	291.2	237.4
FEB	48.9	66.9	98.0	133.7	157.3
MAR	128.1	52.4	46.7	139.4	77.9
APR	79.3	59.4	45.0	108.5	81.0
MAY	69.6	68.2	114.1	214.3	118.2
JUN	215.7	181.8	159.6	185.1	237.5
JUL	240.8	289.2	261.6	313.1	336.5
AUG	195.2	265.7	216.8	304.5	273.7
SEP	274.5	226.4	226.8	277.5	270.6
OCT	213.4	240.9	302.9	311.9	111.7
NOV	158.8	148.2	254.9	278.7	144.2
DEC	230.2	260.7	265.5	354.6	214.3

Source: PAGASA

[9] See Dacuycuy (2016).

Figure 1. Distribution of Rainfall in the Philippines, 2014 and 2018

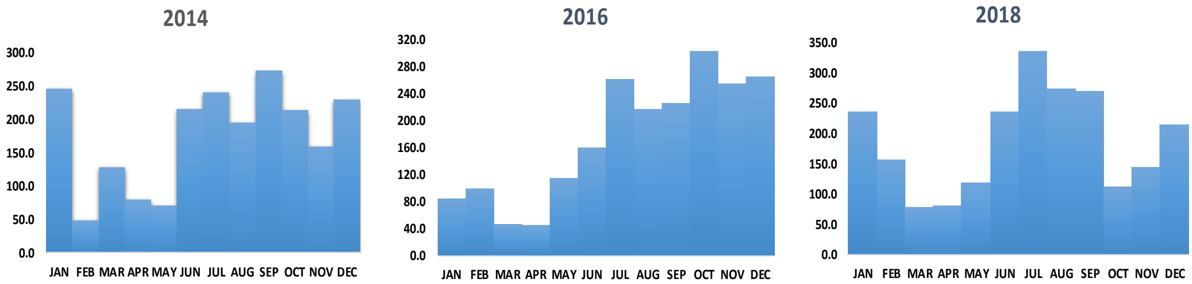


Source: PAGASA

Figure 1 maps out the average rainfall for 2014 and 2018 for the entire Philippines. It can be gleaned that the regions at the upper north-western and the south-eastern parts of the country are prone and had the most or the heaviest rainfall relative to the other regions. These are the same areas that are frequently visited by tropical storms or typhoons, which is not surprising given their proximity to the Pacific Ocean and the natural trajectory of typhoons in the Philippines. As earlier indicated, the provinces of Samar and Leyte are parts of the Eastern Visayas region with few banking establishments, second only to ARMM.

Interestingly, the maps show some slight changes in the geographical or regional pattern and distribution of rainfall between 2014 and 2018. In particular, the map for 2018 has the most regions with dark blue shades, it would appear that 2018 had the greatest number of extreme rainfall episodes than 2014, indicating the possibility of increasing heavy rainfall episodes in the years ahead.

Figure 2. Average monthly rainfall: 2014, 2016, 2018



Source: PAGASA

From the foregoing, the areas with the least number of banking establishments, i.e., Eastern Visayas and the ARMM, are also the same regions that are either prone to extreme weather condition or has a perennial peace and order problem. It is interesting to note that those areas where banks predominate, such as the NCR and Central Visayas regions, are also the regions with generally favorable, moderate weather conditions and manageable peace and order situations.

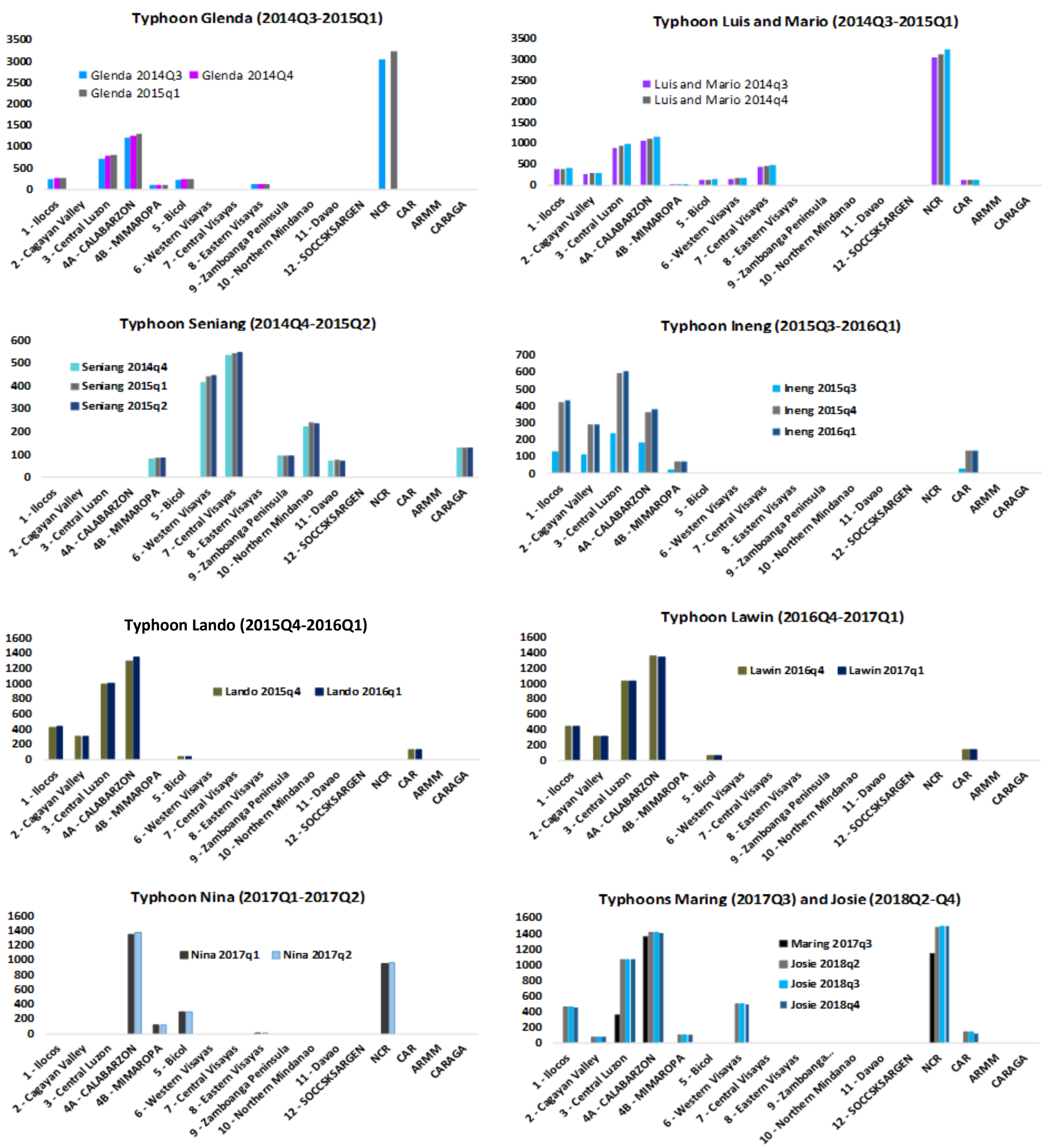
Supervisory Data on Regulatory Relief. The BSP provided temporary regulatory reliefs in the past to borrowers, banks and non-banks with quasi-banking functions which are located in areas affected by calamities. These included those affected by Super Typhoon "Yolanda" (November 2013), "Agaton" (February 2014), "Glenda" (August 2014), "Luis" (October 2014), "Mario" (October 2014), "Lando" (July 2015), "Ineng" (October 2015), and "Seniang" (January 2015), "Ruby" (December 2016), "Nina" (January 2017), "Maring" (October 2017), and "Josie" (August 2018).

Table 4. Number of Banking units that were placed under regulatory relief: 2014Q3 - 2018Q4

Regions	Banking units that were granted relief package at least once	% Share to Total Banking Establishments
1 - Ilocos	4,435	59.19
2 - Cagayan Valley	2,418	44.49
3 - Central Luzon	10,714	60.50
4A - CALABARZON	17,534	74.96
4B - MIMAROPA	1,309	43.23
5 - Bicol	1,714	34.94
6 - Western Visayas	3,080	34.16
7 - Central Visayas	2,283	20.35
8 - Eastern Visayas	594	21.26
9 - Zamboanga Peninsula	281	9.29
10 - Northern Mindana	697	13.49
11 - Davao	218	3.74
12 - SOCCSKSARGEN	0	-
NCR	16,923	28.41
CAR	1,370	58.42
ARMM	0	-
CARAGA	383	15.80
Total	63,953	38.29

Source: PAGASA

Figure 3. Number of banks placed under regulatory relief following the typhoons that struck the regions*



**Prior to October 2018, areas officially under states of calamity are automatically granted regulatory relief by the BSP. BSP Circular 1017 dated September 2018 rationalized the granting of regulatory relief, requiring banks located in areas under a state of calamity to formally notify the BSP of their intention to avail of the relief package within a period of one (1) year from the date of declaration of state of calamity.*

This set of regulatory relief aims to assist affected banks in their recovery and allow them to resume normal operations. This has been institutionalized in the form of a Circular in October 2018. The BSP Circular 1017 in particular, outlines a uniform and systematic approach before the BSP can announce regulatory relief for banks and quasi-banks (QBs) operating in towns or provinces which have been ruined by calamities. The rules specifically require that an area needs to be placed under a state of calamity before the BSP can extend relief to bank branches operating there. This may come from a declaration issued by local government units or by the President, as recommended by the National Disaster Risk Reduction and Management Council. In addition, thrift, rural, and cooperative banks are allowed to exclude outstanding loans from borrowers in the covered areas in computing their past due ratios, provided that such borrowings are restructured or given relief. The BSP would also not impose penalties even if reserves fall below requirement, while those under rehabilitation may take a pause in settling their monthly dues with the BSP. Likewise, no fines are imposed for delayed submissions of regulatory reports to the BSP. Lenders which have outstanding rediscount loans with the BSP can also extend the payment period up to five years. These arrangements are valid for one year following the declaration of state of calamity in the area. By providing temporary relief, the BSP effectively relaxes capital and liquidity requirements imposed in order to ease the burden on financial firms and allow them to recover from disrupted services.

Supervisory data show that almost all regions were granted regulatory relief packages from the third quarter of 2014 to the fourth quarter of 2018, except SOCCSARGEN and the ARMM. Topping the list with the greatest number of regulatory relief packages received are banks located in the CALABARZON, NCR and Central Luzon regions. As mentioned in previous section, these regions also have the greatest number of banking units, more than triple to those regions along the typhoon gateway. While storms most frequently make landfall on Eastern Visayas and the Bicol region, these move from east to west across the country before heading north and exiting the Philippine area of responsibility. Often, areas within the NCR, CALABARZON and Central Luzon regions are at the tail-end of typhoons, usually accompanied by heavy rains despite its dissipating intensity and strength.

Rainfall Damage Index (RDI). In order to measure the impact of intense rainfall episodes, a rainfall damage index was constructed. The rainfall damage index follows the hurricane destruction index proposed by the paper of Emanuel (2011). The hurricane destruction index considers a damage function that produces positive values only for winds speeds in excess of a specified threshold. On physical grounds, the hurricane destruction index expects that damage should vary as the cube of the wind speed over a threshold value. To construct the said index in this study, wind speed in the original index was replaced with the amount of rainfall. Hence, the rainfall index used in this article is seen in equation 1 as,

$$f = \frac{v_n^3}{1+v_n^3}, \qquad \textit{(eq. 1)}$$

where f is the fraction of the property value lost, and

$$v_n \equiv \frac{MAX[(V - V_{thresh}), 0]}{V_{half} - V_{thresh}} \qquad \textit{(eq. 2)}$$

where V is the actual rainfall amount for , V_{thresh} is the rainfall at and below which no damage occurs, and V_{half} is the rainfall amount at which half the property value is lost. V_{thresh} is obtained from the climatological normal amount of rainfall in a month for each region as prescribed by PAGASA. V_{half} is computed as two standard deviations above the climatological normal for each region. The two standard deviation was derived from historical amounts that were recorded in events that produced massive and damaging floods, such as Typhoons Ondoy, and Habagat in 2012.

It can be argued that it may not be precise to simply substitute rainfall amount in the hurricane destruction index, given that the formula is tailored to the dynamics of wind speed. However, given the limitation of the data as discussed in previous section, we deem that employing this hurricane destruction index is a reasonable proxy to a more appropriate rainfall damage index. Moreover, to construct an index that fully measures the destructive capabilities of intense to extreme rainfall episodes requires several variables.

It should be noted that damages from extreme rainfall episodes come in the form of flash floods, which can cause loss of life and material losses. According to Guzzetti et al (2008), critical rainfall thresholds for predicting flash floods can be defined in two ways: (a) using empirical or statistical methods applied widely to early warning systems because of their easy implementation (Glade et al, 2000; Aristizábal et al, 2011), and (b) using numerical physical models which are more complex to define and apply (Iverson, 2000; Crosta and Frattini, 2003). The rain threshold is defined as the minimum or maximum level of a certain amount of precipitation, after which a process occurs (Reichenbach et al, 1998). Critical rainfall threshold was constructed using accumulated rainfall (AR) and the accumulated antecedent rainfall (AAR) in the study of Avila et al (2015). The AR is the short-term rain and represents the amount of rain in the days immediately prior to the occurrence of the event. Meanwhile, the AAR is the long-term rain, corresponding to the amount of rain in the 10 days preceding those that were considered in the AR.

3. Empirical Methodology

Regressions have been carried out using a Dynamic Panel Data (DPD) model based on Generalized Method of Moments (GMM) following Arellano and Bond. This model is suitable for the analysis in this study given: (a) a large cross-section and a relatively short time dimension; (b) the inclusion of the lagged dependent variable; (c) the presence of endogenous regressors that may be correlated with the past/current realizations of the error term, (d) fixed individual effects, and (e) the presence of heteroskedasticity and autocorrelation within but not across cross sections.

Panel GMM estimation. In estimating the impact of extreme rainfall events on the banking sector, a contemporaneous and lagged rainfall index (up to four quarters), as well as interacted variables of rainfall index with past values were regressed against bank variables[10] per branch. This model below is a slightly modified version of the model employed by Brei et al (2019), with the inclusion of an interacted variables. Such an approach is meant to determine the dynamics of more granular data, in this case between the balance sheet data and rainfall index.

[10] Total loans, total deposit liabilities, non-performing loans (NPL), net profit, and return on assets (ROA).

$$BankIndicators_{b,t} = \alpha_{b,t} + \sum_{n}^{4} \beta_n RainIndex_{b,t-n} + \sum_{n}^{4} \beta_n RainIndex_b X\, RainIndex_{b,t-n} + \varepsilon_{b,t} \qquad \textit{(eq. 3)}$$

where $BankIndicators_{b,t}$ is a vector of bank variables of branch b at time t ; $RainIndex_{b,t}$ is the constructed rainfall damage index per region which is applied to branch *b*, and $Rainfall\ X\ Rainfall_{t-n}$, is the interacted variable of contemporaneous rainfall index with its lagged values. Such an approach is meant to determine the dynamics of more granular data, in this case between the branch-level balance sheet data and rainfall index.

Dummy variables. Quarterly dummy variables are added to all the equations - *SQ1 (first quarter), SQ2 (second quarter), SQ3 (third quarter) and SQ4 (fourth quarter).* However, *SQ4* exhibited multicollinearity with the rest of the quarterly dummies and had to be removed from equations 1-25.

Dummy variables for the banking groups (or types of banks) per region have also been included. *DUKB* of 1 if the number of universal/commercial bank branches are greater than thrift banks and rural/cooperative bank branches in the region, 0 otherwise; *DTB* of 1 if the number of thrift bank branches are greater than universal/commercial and rural/cooperative bank branches in the region, 0 otherwise; and *DRCB* of 1 if the number of rural bank/cooperative bank branches are greater than universal/commercial and thrift bank branches in the region, 0 otherwise. As expected, simultaneous regression of the dummy variables for the banking categories *(DUKB, DTB, DRCB*) and interaction with the rainfall data led to multicollinearity. Moreover, there was no dummy for the TB (i.e. *DTB* is zero), since there was no region where TB branches are greater than UKB and RCB bank branches. Hence, separate regressions were conducted across branch-level supervisory data (equations 8-15).

The estimations also controlled for regions that are prone to extreme rainfall events. Dummy *DEXT* of 1 for regions and branches prone to extreme rainfall events, 0 otherwise; Dummy *DNEXT* of 1 for regions and branches not prone to extreme rainfall events, 0 otherwise. These dummy variables were then interacted with extreme rainfall index. However, the inclusion of these dummy variables in the Panel GMM regressions produced multicollinearity. Separate regressions (random effects) were then conducted in order to avoid multicollinearity, with only the interacted *DEXT* and *DNEXT* not exhibiting multicollinearity (equations 18-25).

Robustness checks. Descriptive diagnostics tests are used to check the stability of data used in the study. To check the robustness of the results, the paper uses dynamic panel specification tests, namely, Hansen's overidentification test and Arellano-Bond serial auto-correlation test. The significance of estimates used are 1 percent, 5 percent and 10 percent levels of significance. The different cost of funding variables is likewise checked for robustness of results.

To address the reporting issue by some banks mentioned in the previous section, a separate quartile regression was performed on selected indicators.[11] The results show that

[11] This result was reported in the Bank Deposit Interest Rates Report to the Monetary Board on 27 July 2018.

there is no significant difference between these selected indicators of NCR banks with those of non-NCR banks. This finding indicates that the reporting issue did not significantly affect the quality of the sample used.

Other branch-level balance sheet data were also included in some equations. We included two equations on growth in total loans (equation 6) and return on assets (equation 7) to check the robustness of results. A macroeconomic variable, regional Gross Domestic product (RGDP) to account for regional income was also added in the regressions (equations 16-17).

To check the robustness of the results using different estimation methods, a fixed effect model and a panel Vector Autoregression (VAR) were used. In a fixed effect model, fixed effects estimator is deemed appropriate and useful in this case since it can control for time-variant shocks and time-invariant regional heterogeneity, greatly restricting potential endogeneity issues especially when robust standard errors are applied.

Meanwhile, impulse response from a panel VAR is used to trace the impact on bank variables. A Cholesky ordering of *Rainfall index*, quarterly regional real gross domestic product (GDP) and bank variables is implemented. The shock from the rainfall event is expected to affect the production of agriculture, which in turn affects regional GDP. Regional GDP then acts as a proxy for income and economic activity, which in turn, can affect bank performance.

4. Results and Discussions

Panel GMM estimation. The results of the GMM estimation in Table 5 show that intense to extreme rainfall has an adverse impact even on a branch level from 2014 to 2018. Growth in deposit liabilities are also significantly affected by extreme rainfall event on a contemporaneous manner. This result is intuitive as individuals would likely keep or withdraw their cash in times of disaster as a precautionary measure. In terms of asset quality, growth of non-performing loan will be affected by extreme rainfall events, with the impact coming in as early as one to two-quarter lag. This implies that those affected would likely use their liquidity for more urgent needs rather than to pay loans. In terms of profitability, extreme rainfall events have a negative impact on the net profit of a branch of a bank. Return on assets are likewise adversely affected by extreme rainfall events.

Moreover, loan growth appears to be negatively affected by the four-quarter-lag of the rainfall index. This lag effect on loan portfolio maybe regarded side-by-side with the positive increase in NPL. Considering the high incidence of loan default after an extreme rainfall episode, it is expected for banks to be cautious and risk-averse that they are inclined to suspend and restrict new loan applications.

The results so far are robust after controlling for quarterly seasonal factors and other related branch-level supervisory data. Results in Equations (6) and (7) show that the negative impact of extreme weather events on loan growth (equation 6) is immediate and can be felt up to the second-quarter-lag of the rainfall index even when controlled for quarterly seasonal factors and growth in bank deposits—both of which turned out to have positive significant impact. The same negative impact is likewise seen on the banks' ROA (equation 7), only this time the impact is realized on the first- and third-quarter-lag of the rainfall index and on the third quarter of the period covered. This is insightful since it would take some time before the impact is reflected in the aggregate returns. However, regulatory relief has no significant bearing on either simulation.

Meanwhile, Table 5 shows the immediate adverse effect of severe rainfall on all identified bank variables. While the negative impact on NPL holds no quick and easy cogent justification, the persistent positive growth from the onset up to the third-quarter-lag of the rainfall index may be expected as loan defaults are likely to occur when disaster strikes. And as previously explained, this tendency can prompt bank officials to be more cautious in processing loan applications, hence the negative loan growth. Poor turnouts on deposit liabilities, bank profit and return on assets maybe attributable to banks' tendency to adjust their asset structure in the midst of extreme natural calamities.

Interestingly, the quarterly seasonal variables incorporated into the equations mostly yielded positive coefficients (equations 1 to 5). The impact is most significant for loan growth, as well as growth in overall aggregate net profit and ROA, indicating the influence of seasonal variation on the pace with which banks recover from extreme weather conditions. It is also interesting to note the positive loan growth during the third quarter, which is the peak of the rainy season on the country. This in effect, confirms widely-held assumption that weather conditions can have substantial impact on banking operations. Such an impact on loan growth should be viewed alongside the positive increase in overall net profit and ROA considering that loans are one of the traditional sources of bank income. Meanwhile, regulatory relief is seen to have encouraging effect on bank deposit and NPL growth, albeit the sign is insignificant on the latter.

To account for the greater number of UKB branches in most regions in the country (only in regions 2 and IV-A where branches of RBs are higher than UKB branches), Equations 18 to 25 incorporate dummy variables for different bank types. It would appear that the strong negative impact of extreme weather on rural and cooperative banks is channeled through loans and bank deposits. A similar negative coefficient on loan growth is observed in the interaction between the dummy variables for UKBs and episodes of extreme rainfall. Meanwhile, controlling for quarterly seasonal variation and bank types generated mostly positive significant coefficients when regressed against loan growth and changes in deposit liabilities and ROA. On the whole, what these results imply is that weather conditions do have substantial impact on banking operations particularly on loans, deposit liabilities and overall net profit and ROA. It seems that the impact only becomes negative and deleterious when the weather conditions take a turn for the worse.

Controlling for regional income as represented by regional GDP, income has a positive relationship with loan uptake (equation 16). Meanwhile with regards to return on assets, regional GDP has a positive coefficient, albeit insignificant (equation 17). Interacting regional GDP with the rainfall index shows a negative relationship with the dependent variable, although insignificant.

Likewise, in equations 18 to 25, we compared regions that are prone to extreme rainfall with those that experience normal rainfall by including a dummy variable and interacting it with the rainfall index as indicated by *DEXT* for regions that are prone to extreme rainfall and *DNEXT* for those that are not prone to the said condition. We can see that regions which are prone to extreme rainfall events are relatively more susceptible to adverse impact.

Table 5: Panel GMM Estimation Results

	Dependent Variable				
Equation	**1**	**2**	**3**	**4**	**5**
	DLOG(TLOANS)	**DLOG(TDEPLIAB)**	**DLOG(NPL)**	**DLOG(NETPROF)**	**D(ROA)**
Explanatory Variables					
Dependent Variable(-1)	-0.452***	-0.636***	-0.197***	-0.346***	-0.202**
RFALL_INDEX	-0.208**	-0.004***	0.037*	-0.006**	-0.009**
RFALL_INDEX(-1)	-0.005	0.001	0.038***	-0.003	0.004
RFALL_INDEX(-2)	-0.118	0.001	0.064***	-0.001	0.001
RFALL_INDEX(-3)	-0.568***	-0.006**	-0.005	0.001	-0.011***
RFALL_INDEX(-4)	-0.074	-0.007***	0.010	-0.005**	-0.007*
RFALL_L1	-0.007	-0.001	-0.001	0.001	0.001
RFALL_L2	0.010	-0.004	-0.002*	0.001	0.001
RFALL_L3	0.004	0.001	0.001	0.001	0.001
RFALL_L4	0.005	0.001	0.002	-0.001*	-0.001***
REGRELIEF	-78.005	0.056**	0.165	-1.488	-1.330
SQ1	11.658	0.004	-0.606	-0.192	-0.143
SQ2	43.293***	-0.013	0.0157	0.407*	0.481***
SQ3	5.408	0.057	0.020	0.106	0.052
Observations	*61,696*	*92,941*	*37,248*	*17,739*	*17,720*
Period	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*
Arellano-Bond serial correlation test	*0.000*	*0.000*	*0.350*	*0.348*	*0.795*
Hansen test	*0.079*	*0.102*	*0.362*	*0.101*	*0.048*

*Notes: *** 1% level of significance, ** 5% level of significance, * 10% level of significance*
Source of estimates: Authors.

Table 5: Panel GMM Estimation Results

	Dependent Variable	
Equation	**6**	**7**
	DLOG(TLOANS)	**D(ROA)**
Explanatory Variables		
Dependent Variable(-1)	-0.332***	-0.292***
RFALL_INDEX	-0.007*	-0.008***
RFALL_INDEX(-1)	-0.007*	0.002
RFALL_INDEX(-2)	0.004	0.001
RFALL_INDEX(-3)	0.016	-0.008**
RFALL_INDEX(-4)	0.002	-0.006
RFALL_L1	0.001	0.001
RFALL_L2	-0.001	-0.001
RFALL_L3	-0.003***	0.004
RFALL_L4	0.002	-0.001***
REGRELIEF	0.116	0.029
SQ1	0.880***	-1.342
SQ2	-0.274	-0.241
SQ3	0.199	0.527***
SQ4		
DLOG(TDEPLIAB)	0.546***	-0.327
D(ROA)	0.046	--
DLOG(TLOANS)	--	0.3091
Observations	*17,731*	*16,544*
Period	*2015Q4-2018Q4*	*2015Q4-2018Q4*
Arellano-Bond serial correlation test	*0.170*	*0.968*
Hansen test	*0.744*	*0.098*

*Notes: *** 1% level of significance, ** 5% level of significance, * 10% level of significance*
Source of estimates: Authors.

Table 5: Panel GMM Estimation Results

	Dependent Variable			
Equation	**8**	**9**	**10**	**11**
	DLOG(TLOANS)	**DLOG(TDEPLIAB)**	**DLOG(NPL)**	**D(ROA)**
Explanatory Variables				
Dependent Variable(-1)	-0.004	-0.329**	-0.199	-0.376
RFALL_INDEX	1.067	-0.022*	-0.047	-0.010
RFALL_INDEX(-1)	0.217	-0.005*	0.018*	-0.005
RFALL_INDEX(-2)	0.145	-0.001	0.039**	-0.005
RFALL_INDEX(-3)	-0.164	0.012	-0.006	0.003
RFALL_INDEX(-4)	-0.194	-0.002	0.018	-0.008***
DUKB*RFALL_INDEX [a]	-0.948**	0.0137	0.060	0.004
SQ1	-9.367**	0.158***	-0.257	-1.389***
SQ2	-5.432**	0.116	-0.540	-0.228
SQ3	-6.560**	0.123***	-0.296	0.481***
Observations	*54,686*	*92,491*	*37,248*	*17,720*
Period	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*
Arellano-Bond serial correlation test	*0.679*	*0.201*	*0.843*	*0.138*
Hansen test	*0.054*	*0.013*	*0.322*	*0.086*
Equation	**12**	**13**	**14**	**15**
	DLOG(TLOANS)	**DLOG(TDEPLIAB)**	**DLOG(NPL)**	**D(ROA)**
Explanatory Variables				
Dependent Variable(-1)	-0.5418***	-0.3021	-0.2792	-0.3759
RFALL_INDEX	0.1165	-0.0039	-0.0143	-0.0061**
RFALL_INDEX(-1)	0.0196	-0.0084	0.0430	-0.0048
RFALL_INDEX(-2)	0.0147	0.0070	0.0517	-0.0049
RFALL_INDEX(-3)	-0.1389***	0.0147	0.0299	0.0034
RFALL_INDEX(-4)	-0.0123	0.0111	0.0499	-0.0084***
DRCB*RFALL_INDEX[a]	-0.2729***	-0.0807***	0.0049	-0.0041
SQ1	-10.01038	1.3891	-0.1211	-1.3885
SQ2	-9.3860***	-1.2684	-0.4781	-0.2284
SQ3	5.5577***	-0.9261	-0.5420	0.4814***
Observations	*61,696*	*92,491*	*37,248*	*17,720*
Period	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*
Arellano-Bond serial correlation test	*0.778*	*0.273*	*0.774*	*0.138*
Hansen test	*0.032*	*0.570*	*0.437*	*0.086*

Notes: [a] Coefficients for DUKB and DRCB were not included in Table 5. Estimated using random effects.
**** 1% level of significance , **5% level of significance, * 10% level of significance*

Source of estimates: Authors.

Table 5: Panel GMM Estimation Results

	Dependent Variable	
Equation	**16**	**17**
	DLOG(TLOANS)	**D(ROA)**
Explanatory Variables		
Dependent Variable(-1)	-0.528	-0.442
RFALL_INDEX	0.077	0.041
RFALL_INDEX(-1)	-0.005	0.002
RFALL_INDEX(-2)	-0.003	0.001
RFALL_INDEX(-3)	-0.010	-0.002
RFALL_INDEX(-4)	0.001	-0.012***
REGRELIEF	-0.089	0.044
DLOG(TDEPLIAB)	0.056	0.035
D(ROA)	-0.015	--
DLOG(LOANS)	--	-0.006
RGDP	2.505	1.713
RGDP*RAINFALL	-0.006	-0.004
SQ1	0.038***	-1.382
SQ2	0.152	-0.334
SQ3	0.234***	0.546
Observations	17,731	16,544
Period	2015Q4-2018Q4	2015Q4-2018Q4
Arellano-Bond serial correlation test	0.909	0.015
Hansen test	0.505	0.031

*Note: *** 1% level of significance , **5% level of significance, * 10% level of significance*
Source of estimates: Authors.

Table 5: Panel GMM Estimation Results

	Dependent Variable			
Equation	**18**	**19**	**20**	**21**
	DLOG(TLOANS)	**DLOG(TDEPLIAB)**	**DLOG(NPL)**	**D(ROA)**
Explanatory Variables				
Dependent Variable(-1)	0.1160	-0.5354	0.1874	-0.3720
RFALL_INDEX	0.9273*	-0.0099	0.0013	-0.0051
RFALL_INDEX(-1)	0.7812*	-0.0082	0.0115	-0.0029
RFALL_INDEX(-2)	0.7721*	-0.0036	0.0395***	-0.0047
RFALL_INDEX(-3)	-0.0596	0.0064	0.0063	0.0013
RFALL_INDEX(-4)	-0.0959	0.0022	0.0158	-0.0107*
REGRELIEF	-10.8152	-0.5034	0.3727	0.1144
DEXT*RFALL_INDEX	-1.0983**	-0.1509	0.1153	-0.0037
SQ1	-8.7343	0.0232	-0.0701	-1.3909
SQ2	-19.2460	0.1634	-0.1432	-0.2687
SQ3	-7.3494	0.1758	-0.1570	0.4324***
Observations	*61,696*	*92,941*	*37,248*	*17,720*
Period	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*
Arellano-Bond serial correlation test	*0.622*	*0.056*	*0.886*	*0.241*
Hansen test	*0.748*	*0.082*	*0.345*	*0.162*
	Dependent Variable			
Equation	**22**	**23**	**24**	**25**
	DLOG(TLOANS)	**DLOG(TDEPLIAB)**	**DLOG(NPL)**	**D(ROA)**
Explanatory Variables				
Dependent Variable(-1)	-0.1724	-0.5478	-0.2867	-0.3720
RFALL_INDEX	-1.9000	-0.1698**	-0.0777	-0.0088*
RFALL_INDEX(-1)	0.1011	0.0034	0.0099	-0.0029
RFALL_INDEX(-2)	0.5401***	0.0030	0.0490	-0.0047
RFALL_INDEX(-3)	-0.4792	-0.0044	0.0471	0.0013
RFALL_INDEX(-4)	0.0439	-0.0003	0.0406	-0.0107*
REGRELIEF	3.0700*	-0.6158	2.4707	0.1144
DNEXT*RFALL_INDEX	2.0313	0.1751	0.0715	0.0037
SQ1	-7.6556	-0.0801	11.9555	-1.3909
SQ2	-4.3936	-0.1156	6.9584	-0.2687
SQ3	-2.9725	0.0211	0.4312	0.4324
Observations	*61,696*	*92,491*	*37,248*	*17,720*
Period	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*	*2015Q4-2018Q4*
Arellano-Bond serial correlation test	*0.5518*	*0.005*	*0.040*	*0.241*
Hansen test	*0.024*	*0.070*	*0.855*	*0.162*

Notes: [a] Coefficients for DEXT and DNEXT were not included in Table 5. Estimated using random effects.
**** 1% level of significance , **5% level of significance, * 10% level of significance*
Source of estimates: Authors.

Fixed Effects Estimation (Annex 2). A fixed effect model was used to check the robustness of the results. The results confirm the negative impact of heavy rainfall on bank resources and operations.

In particular, the effect of severe rainfall is seen almost instantaneously on bank deposit liabilities and non-interest expense—negative for deposit liabilities, positive impact in the case of non-interest expense. As explained in previous section, extreme weather conditions may have a negative bearing on banks' deposit liabilities, as individuals tend to hold on to their cash and/or withdraw more in anticipation of losses and possible emergency needs. Meanwhile, the effect on non-interest expense is positive probably in view of the direct or indirect damages to bank facilities and possible operational downtime or disruptions in business activities during extreme rainfall episodes. Non-interest expense would generally include operational expenses and expenses related to the day-to-day operation of a bank, such as salaries and bonuses to staff, marketing, and equipment expenses.

The severity of rainfall also affects banks' overall bottom line, as demonstrated by the results for our income and profit metrics, most notably net interest income, operating income and net profit. The signs for all three coefficients almost matched and are significant for all lagged terms of the rainfall index variable, with alternating positive and negative signs in between quarters. This is not surprising considering that these are all income-related accounts. Nevertheless, the deceleration in deposit growth and the subsequent rise in NPLs which feed into the banks' net earnings, may have also contributed to the observed deterioration in bank profitability.

Meanwhile, the impact of a dummy variable for regulatory relief indicates mixed results as it is shown to significantly improve bank profit and income even as non-interest expense, deposit liabilities and return on assets deteriorate. Similar tests for NPL and loan growth returned with the appropriate or expected signs (i.e., negative for NPL and positive for TLP) but were found to be insignificant. We take this as an area for future research. Regulatory relief packages which in effect defer the recognition of NPLs, ease rediscounting rules as well as penalties for probable delays in the submission of supervisory reports are expected to cascade to indebted households through debt moratoria. These packages may help banks recover, resume normal operations and earn profit; however, some losses and damages still need to be resolved and absorbed by the banks, which could adversely affect long-term asset returns.

Importantly, banks are expected to follow the Business Continuity Plan following a disaster. Under Circular No. 951 dated 20 March 2017 on Guidelines on Business Continuity Management, the BSP has required all banks and financial firms to craft quick recovery protocols for branches and offices to resume offering financial services even in disaster-hit areas, as part of overall standards on operational risk management. For most banks, they adopt buddy branches, meaning, branches in nearby areas not severely affected by the disaster can support the clients of the affected branches. In the case of Domestic Systemically Important Banks (DSIBs), they are given up to four hours as the maximum response time to resume operations when disaster strikes. The said Circular covers banks, quasi-banks, money service businesses, and other BSP-supervised financial institutions (BSFIs). The regulation underscores the crucial role of banks in ensuring that their operations can withstand the effects of major disruptions. The comprehensive framework covers the entire business, which should outline the policies and protocol for the "continuous functioning" of the institution despite disruptions. In particular, the plan should outline the speedy process for recovery, resumption, and restoration of business services as captured by a communication plan, crisis management plan, contingency funding, and technology recovery.

Moreover, a separate regression exercise was also performed on regular peso savings and peso-time deposit accounts. The results show strong negative impact of intense rainfall on both accounts. The impact is more direct and strongest on the levels of regular peso savings deposits, which is intuitive since savings account can easily be withdrawn since banks in the regions are the main repository for household savings and also hold a large amount of government savings (largely from local government units and government agencies) compared to other financial institutions (Worrell et al 2001). Similar effect was noted on peso-time deposit account which has fixed maturities, but the impact is gradual as shocks were seen to effect only after two or three –quarter lag especially for higher or bigger-bucket account holdings with longer maturities. Banks, in turn, may likely change their investment decisions moving forward. However, no significant impact was detected when the same accounts were regressed against extreme rainfall events using the panel GMM model. This could indicate that the affected accounts are not that big or that account holders may have transferred their deposit balances to another branch which was not that affected by intense rainfall (Cortes et al 2017). We take this as an area for future research.

Panel VAR estimation (Annex 1). To further check the robustness of the GMM estimation results and to trace the persistence of the shock from intense to extreme rainfall events on banking variables, a panel Vector Autoregression (VAR) was used. The impact of an extreme rainfall event was transmitted to lower quarterly regional gross domestic product (RGDP) as a proxy for regional economic activity and income. The consequent impact on regional GDP is then traced to bank-specific variables. The results from Impulse Response show that extreme rainfall events have a positive (rising NPLs) significant impact on non-performing loans after three and four quarters before, after which, the shock dies down. In terms of profitability, ROA is adversely affected after one and three quarters before the shock dies down.

5. Conclusion

This study examined the impact of extreme weather conditions on branch-level bank-specific variables using the BSP's BRIS. Using Brei et al's (2019) model, the study first constructed a regional rainfall damage index based on rainfall statistics from 53 synoptic stations of PAGASA from 2014 to 2018. The study then used the estimated RDI to determine the impact of extreme rainfall on selected bank-specific variables from a panel dataset of over 92,000 branches across the Philippines using a Dynamic Panel GMM from 2014 to 2018. The results showed that episodes of extreme weather conditions adversely impact financial intermediation following the negative effect on growth of deposits and loans, loan quality and profitability. In particular, the results found savings and time deposit liabilities dropped while non-performing loans surged following the extreme rainfall events from 2014 to 2018. These are particularly evident in regions most vulnerable to extreme rainfall episodes and to branches of universal and commercial banks as well as of rural and cooperative banks. However, the overall negative impact on profitability eventually tapered off. These findings are robust across different specifications and alternative estimation methods such as fixed effects and Panel Vector Autoregression estimations.

The findings provide compelling evidence that the financial system is not impervious from the effects of natural disasters and climate change. The significant results on banking indicators suggest that there are indeed direct costs to the banks and when the indirect costs from clients and transaction partners are integrated, these can seriously affect the operations and health of the financial institutions.

There are areas for future research. One is the impact of the history of extreme weather episodes on bank response and performance during or after the shock. Branches that have more experience on natural disasters may have changed their business models and practices. Another is that the age of the branch could be an important indicator in the estimations, which could be indicated by the date of establishment of the branch in the region.

Importantly, the findings take us to the broader implications for microprudential policy. The BSP supervision is risk-based, proportionate and forward-looking, that is tailored to different business models around the sector. The BSP supervisors take a view of banks' business plans, risk management, governance as well as capital and liquidity models. Where the BSP supervisors judge that it is necessary to intervene, it does so sooner rather than later. While our mandate is to ensure the safety, resilience and soundness of BSFIs, the supervisors are mindful that international competition needs robust and internationally consistent regulatory standards.

Moreover, cognizant of the impact of extreme weather conditions on the Philippines, data availability and quality can be improved. Better quality of regional data that reflect the source of loan origination and further breakdowns in industry level datasets per region can be explored. More efforts may be extended towards the proper accounting and recording of past due loans—pre and post regulatory relief, for greater transparency and better validation of disaster relief policy.

As a matter of policy, the BSP has taken a broader policy perspective on sustainable finance, as it encompasses governance – a key element in the supervisory framework for financial institutions; and socio-economics – one of the factors that underpin the BSP's advocacy for financial inclusion. To this end, the BSP has taken a two-pronged approach to sustainable finance: undertaking capacity building and promotion, and second, mainstreaming governance standards through the issuance of supporting regulations. In promoting awareness and building institutional capacity, the BSP highlights that sustainable finance is ultimately a public good that when done effectively, translates into profitable returns, while at the same time, attain environmental and social objectives. The BSP advocates that there is a business case for banks to revisit the way they operate by embedding sustainable finance principles and tools in their operations.

On 29 April 2020, the BSP issued Circular No. 1085 on the Sustainable Finance Framework. The Circular sets out the BSP's expectations on the integration of sustainability principles in the corporate governance and risk management frameworks as well as the strategic objectives and operations of banks. At present, several Philippine banks are in various stages of implementing their green finance or sustainability initiatives. Some banks have adopted sustainability as part of their corporate social responsibility (CSR) initiatives while others have gone farther to integrate ESG principles into their business operations even before the release of Circular 1085.

There are banks that have voluntarily adopted sustainability principles and ESRM in their operations. These initiatives include the creation of Sustainable Energy Finance (SEF) Desks, which serves as the point-of-contact in evaluating and monitoring sustainable energy projects. The SEF is a program launched with the IFC which is designed to encourage local enterprises to invest in renewable energy and energy efficiency solutions. The SEF Desk also offers capacity-building activities for more awareness on sustainable finance and ESG concepts. A local bank has also adopted voluntary reporting of sustainability performance and established partnerships with international experts to assess and address climate change risks. Such bank engaged with World Wildlife Fund (WWF) in the conduct of scoping study on climate vulnerable cities; as well as with the IFC in granting loans under the Risk Sharing Facilities.

With respect to issuance of green or sustainability bonds, there were four banks which have issued green bonds. These included BDO (International Finance Corporation or IFC as the sole investor – US$150 million); China Bank (IFC as the sole investor – US$ 150 million); RCBC (January 2019; P15 billion) and BPI (September 2019, US$ 300 million). Proceeds were used to fund and refinance renewable energy and energy efficiency projects, green buildings and other green assets.

On 4 June 2019, RCBC launched the issuance of the P8 billion sustainability bonds, the first in the Philippines under the ASEAN Sustainability Bond Standards 2018. Proceeds of said bond issuance will fund projects such as renewable energy, green buildings, clean transportation, energy efficiency, pollution prevention and control, sustainable water management, environmentally sustainable management of living natural resources and land use, affordable basic infrastructure, access to essential services, employment generation, affordable housing and socioeconomic advancement and empowerment.

The government financial institutions are likewise active in this space. They have implemented financing programs primarily to assist strategic sectors (MSMEs), industries and Local Government Units (LGUs) in adapting environment friendly processes and technologies and incorporating climate change adaptation and mitigation and disaster risk reduction measures by providing financing and technical assistance. The Development Bank of the Philippines (DBP) has a Green Financing Program (GFP), an umbrella program to support the Bank's strategic thrust of environmental protection and the country's green growth strategy. The Program was designed primarily to assist strategic sectors, industries and LGUs in adapting environment friendly processes and technologies and incorporating climate change adaptation and mitigation and disaster risk reduction measures by providing financing and technical assistance.

The BSP regulations also emphasize the adoption of appropriate credit and operational risk management systems to ensure that various risks including environmental issues and climate change risks are considered in the banks' decision-making process. The BSP had also issued the guidelines on stress testing exercises. The BSP has engaged banks in discussions to include climate-related events in the stress scenarios and likewise consider the potential impact in their capital planning and business continuity arrangements.

In October 2019, the BSP affirmed its broader commitment to support environmentally responsible finance and investment practices by investing in the green bond fund launched by the Bank for International Settlements (BIS). The BSP also became a member of the advisory committee created by the BIS to give guidance on the objectives of the initiative and the features of the fund, which is designed to help central banks incorporate environmental sustainability objectives in reserve management.

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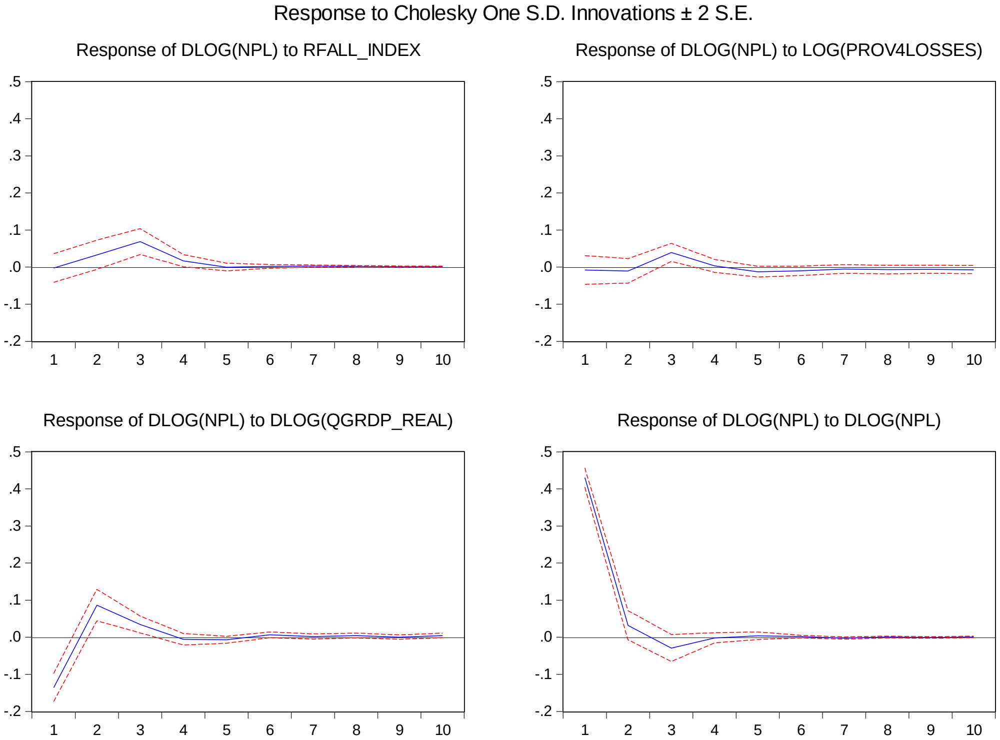
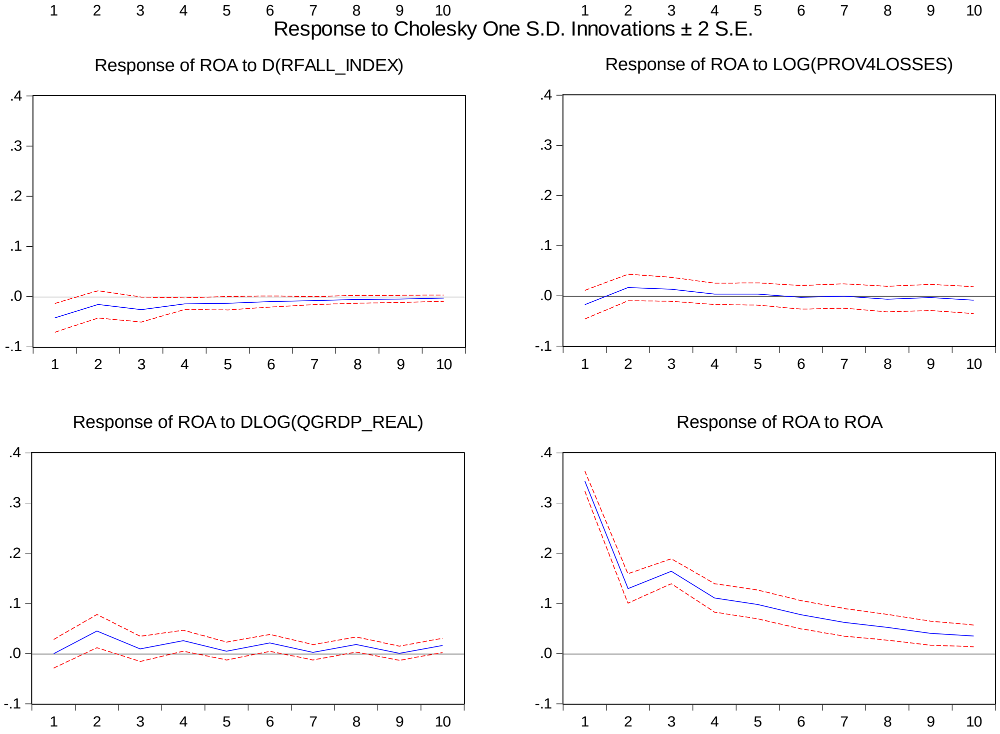
Annex 1. Impulse response of bank variables from rainfall shocks





Source of Panel VAR runs: Authors.

Annex 2. Results of Fixed Effects Estimation Model

	DLOG (Deposit Liabilities)	DLOG (Total Loans)	DLOG (Net Interest Income)	DLOG (NPL)	DLOG (Net Profit)	DLOG (Non-Interest Expense)	DLOG (Non-Operating Income)	DROA
DV (-1)	0.0471***	0.0192**	0.0350***	0.0397**	0.0709***	-0.1030**	0.0215**	0.0104***
rfall_index	-0.0001**	0.0000	-0.0010**	-0.0001	-0.0001	0.0023***	-0.0005	-0.0002
rfall_index1	-0.0002***	-0.0005*	0.0035***	-0.0002	0.0037***	0.0047***	0.0031***	-0.0002
rfall_index2	-0.0002***	0.0011***	-0.0015***	-0.0010**	-0.0016***	0.0004***	-0.0013***	0.0001
rfall_index3	-0.0003***	0.0011***	0.0083***	-0.0002	0.0067***	0.0111***	0.0084***	-0.0002***
rfall_index4	-0.0001**	0.0004	-0.0066***	-0.0003	-0.0064***	-0.0051**	-0.0053***	-0.0001
rfall_L1	0.0000	0.0000***	-0.0001***	0.0000	-0.0002***	-0.0002**	-0.0001***	0.0000
rfall_L2	0.0000	-0.0000***	0.0000*	0.0000	0.0000***	0.0000	0.0000**	0.0000
rfall_L3	0.0000***	0.0000	-0.0000***	0.0000	-0.0000**	-0.0001**	-0.0000***	0.0000**
rfall_L4	-0.0000*	0.0000**	0.0001***	0.0000	0.0000***	0.0001***	0.0001***	0.0000
Reg relief	-0.0073***	0.0049	0.0950***	-0.0272	0.0379*	0.1537***	0.0540***	-0.0329*
N	102731	71123	35815	43697	23235	102132	53598	102527
r2_a	0.0011	0.001	0.0826	0.0001	0.0523	0.069	0.0457	0.0001

*legend: * p<.05; ** p<.01; *** p<.001*

Annex 3. List of Variables Used in Estimations

Variable Code	Variable name	Remarks	Data Source
period2			
period			
trdate			
id2			
id2r			
region	regional name		
bkcode	bank code		
banktype	bank type:	UKBs, TBs, RBs	
bnkname	bank name		
icode			
branchnum	branch number		
branchname	branch name		
bradd	branch address		
reg	regional code		
prov	province code		
province	provincial name		
town	town code		
ttown	town name		
pastdue	Past Due and Non-Performing Loans		
itl	items in litigation		**BSP Branch Regional Information System (BRIS)**
npl	non-performing loans		
nplratio	npl ratio		
acl	allowance for credit losses		
lnrcv	loans and receivables		
tloans	total loans		
tassets	total assets		
tdepliab	total deposit liabilities		
demand	demand deposit		
savings	savings deposit		
time	time deposit		
now	now deposit		
ltncd	ltncd		
tliab	total liabilities		
hb	head office; branch		
qdate			
regn	region		
bkcode1			
br			
isdup			
id			
rps		Regular Peso Savings	
ks		Kiddie Savings	

Variable Code	Variable name	Remarks	Data Source
		Peso Time Deposit	
ptd_less30d01	Below 50,000.00	LESS THAN 30 DAYS	
ptd_less30d02	50,000.00 - 100,000.00		
ptd_less30d03	100,000.01 - 500,000.00		
ptd_less30d04	500,000.01 - 1,000,000.00		
ptd_less30d05	1,000,000.01 AND ABOVE		
ptd_30t59d01	Below 50,000.00	30-59 DAYS	
ptd_30t59d02	50,000.00 - 100,000.00		
ptd_30t59d03	100,000.01 - 500,000.00		
ptd_30t59d04	500,000.01 - 1,000,000.00		
ptd_30t59d05	1,000,000.01 AND ABOVE		
ptd_60t89d01	Below 50,000.00	60-89 DAYS	
ptd_60t89d02	50,000.00 - 100,000.00		
ptd_60t89d03	100,000.01 - 500,000.00		
ptd_60t89d04	500,000.01 - 1,000,000.00		
ptd_60t89d05	1,000,000.01 AND ABOVE		
ptd_90t179d01	Below 50,000.00	90-179 DAYS	
ptd_90t179d02	50,000.00 - 100,000.00		
ptd_90t179d03	100,000.01 - 500,000.00		
ptd_90t179d04	500,000.01 - 1,000,000.00		
ptd_90t179d05	1,000,000.01 AND ABOVE		**BSP Branch Regional Information System (BRIS)**
ptd_180t359d01	Below 50,000.00	180-359 DAYS	
ptd_180t359d02	50,000.00 - 100,000.00		
ptd_180t359d03	100,000.01 - 500,000.00		
ptd_180t359d04	500,000.01 - 1,000,000.00		
ptd_180t359d05	1,000,000.01 AND ABOVE		
ptd_1yrd01	Below 50,000.00	1 YEAR (360-365 DAYS)	
ptd_1yrd02	50,000.00 - 100,000.00		
ptd_1yrd03	100,000.01 - 500,000.00		
ptd_1yrd04	500,000.01 - 1,000,000.00		
ptd_1yrd05	1,000,000.01 AND ABOVE		
ptd_over1yrd01	Below 50,000.00	MORE THAN 1 YEAR	
ptd_over1yrd02	50,000.00 - 100,000.00		
ptd_over1yrd03	100,000.01 - 500,000.00		
ptd_over1yrd04	500,000.01 - 1,000,000.00		
ptd_over1yrd05	1,000,000.01 AND ABOVE		
		Other Peso Savings Deposit Product	
opsd_less30d01	Below 50,000.00	LESS THAN 30 DAYS	
opsd_less30d02	50,000.00 - 100,000.00		
opsd_less30d03	100,000.01 - 500,000.00		
opsd_less30d04	500,000.01 - 1,000,000.00		

Variable Code	Variable name	Remarks	Data Source
opsd_less30d05	1,000,000.01 AND ABOVE		
opsd_30t59d01	Below 50,000.00	30-59 DAYS	
opsd_30t59d02	50,000.00 - 100,000.00		
opsd_30t59d03	100,000.01 - 500,000.00		
opsd_30t59d04	500,000.01 - 1,000,000.00		
opsd_30t59d05	1,000,000.01 AND ABOVE		
opsd_60t89d01	Below 50,000.00	60-89 DAYS	
opsd_60t89d02	50,000.00 - 100,000.00		
opsd_60t89d03	100,000.01 - 500,000.00		
opsd_60t89d04	500,000.01 - 1,000,000.00		
opsd_60t89d05	1,000,000.01 AND ABOVE		
opsd_90t179d01	Below 50,000.00	90-179 DAYS	
opsd_90t179d02	50,000.00 - 100,000.00		
opsd_90t179d03	100,000.01 - 500,000.00		
opsd_90t179d04	500,000.01 - 1,000,000.00		
opsd_90t179d05	1,000,000.01 AND ABOVE		
opsd_180t359d01	Below 50,000.00	180-359 DAYS	
opsd_180t359d02	50,000.00 - 100,000.00		
opsd_180t359d03	100,000.01 - 500,000.00		**BSP Branch Regional Information System (BRIS)**
opsd_180t359d04	500,000.01 - 1,000,000.00		
opsd_180t359d05	1,000,000.01 AND ABOVE		
opsd_1yrd01	Below 50,000.00	1 YEAR (360-365 DAYS)	
opsd_1yrd02	50,000.00 - 100,000.00		
opsd_1yrd03	100,000.01 - 500,000.00		
opsd_1yrd04	500,000.01 - 1,000,000.00		
opsd_1yrd05	1,000,000.01 AND ABOVE		
opsd_over1yrd01	Below 50,000.00	MORE THAN 1 YEAR	
opsd_over1yrd02	50,000.00 - 100,000.00		
opsd_over1yrd03	100,000.01 - 500,000.00		
opsd_over1yrd04	500,000.01 - 1,000,000.00		
opsd_over1yrd05	1,000,000.01 AND ABOVE		
		Peso Time Deposit, less than 30 days	
ptd30d_numacct_b50k	Below 50,000.00	number of accounts	
ptd30d_amt_b50k	Below 50,000.01		
ptd30d_numacct_50kt100k	50,000.00 - 100,000.00	number of accounts	
ptd30d_amt_50kt99k	50,000.00 - 100,000.01		
ptd30d_numacct_100kt499k	100,000.01 - 500,000.00	number of accounts	
ptd30d_amt_100kt499k	100,000.01 - 500,000.01		
ptd30d_numacct_500ktob1m	500,000.01 - 1,000,000.00	number of accounts	

Variable Code	Variable name	Remarks	Data Source
ptd30d_amt_500ktob1m	500,000.01 - 1,000,000.01		
ptd30d_numacct_over1m	1,000,000.01 AND ABOVE	number of accounts	
ptd30d_amt_over1m	1,000,000.01 AND ABOVE		
		Peso Time Deposit, between 30-59 days	
ptd3059d_numacct_b50k	Below 50,000.00	number of accounts	
ptd3059d_amt_b50k	Below 50,000.01		
ptd3059d_numacct_50kt100k	50,000.00 - 100,000.00	number of accounts	
ptd3059d_amt_50kt99k	50,000.00 - 100,000.01		
ptd3059d_numacct_100kt499k	100,000.01 - 500,000.00	number of accounts	
ptd3059d_amt_100kt499k	100,000.01 - 500,000.01		
ptd3059d_numacct_500ktob1m	500,000.01 - 1,000,000.00	number of accounts	
ptd3059d_amt_500ktob1m	500,000.01 - 1,000,000.01		
ptd3059d_numacct_over1m	1,000,000.01 AND ABOVE	number of accounts	
ptd3059d_amt_over1m	1,000,000.01 AND ABOVE		
		Peso Time Deposit, between 60-89 days	
ptd6089d_numacct_b50k	Below 50,000.00	number of accounts	
ptd6089d_amt_b50k	Below 50,000.01		
ptd6089d_numacct_50kt100k	50,000.00 - 100,000.00	number of accounts	**BSP Branch Regional Information System (BRIS)**
ptd6089d_amt_50kt99k	50,000.00 - 100,000.01		
ptd6089d_numacct_100kt499k	100,000.01 - 500,000.00	number of accounts	
ptd6089d_amt_100kt499k	100,000.01 - 500,000.01		
ptd6089d_numacct_500ktob1m	500,000.01 - 1,000,000.00	number of accounts	
ptd6089d_amt_500ktob1m	500,000.01 - 1,000,000.01		
ptd6089d_numacct_over1m	1,000,000.01 AND ABOVE	number of accounts	
ptd6089d_amt_over1m	1,000,000.01 AND ABOVE		
		Peso Time Deposit, between 90-179 days	
ptd90179d_numacct_b50k	Below 50,000.00	number of accounts	
ptd90179d_amt_b50k	Below 50,000.01		
ptd90179d_numacct_50kt100k	50,000.00 - 100,000.00	number of accounts	
ptd90179d_amt_50kt99k	50,000.00 - 100,000.01		
ptd90179d_numacct_100kt499k	100,000.01 - 500,000.00	number of accounts	
ptd90179d_amt_100kt499k	100,000.01 - 500,000.01		
ptd90179d_numacct_500ktb1m	500,000.01 - 1,000,000.00	number of accounts	
ptd90179d_amt500ktb1m	500,000.01 - 1,000,000.01		

Variable Code	Variable name	Remarks	Data Source
ptd90179d_numacct_over1m	1,000,000.01 AND ABOVE	number of accounts	
ptd90179d_amt_over1m	1,000,000.01 AND ABOVE		
		Peso Time Deposit, between 180-359 days	
ptd180359nacct_b50k	Below 50,000.00	number of accounts	
ptd180359damt_b50k	Below 50,000.01		
ptd180359nacct_50kt99k	50,000.00 - 100,000.00	number of accounts	
ptd180359amt_50kt99k	50,000.00 - 100,000.01		
ptd180359nacct_100kt499k	100,000.01 - 500,000.00	number of accounts	
ptd180359amt_100kt499k	100,000.01 - 500,000.01		
ptd180359nacct_500ktob1m	500,000.01 - 1,000,000.00	number of accounts	
ptd180359amt_500ktob1m	500,000.01 - 1,000,000.01		
ptd180359nacct_over1m	1,000,000.01 AND ABOVE	number of accounts	
ptd180359_amt_over1m	1,000,000.01 AND ABOVE		
		Peso Time Deposit, 1 yr	
ptd1yr_numacct_b50k	Below 50,000.00	number of accounts	
ptd1yr_amt_b50k	Below 50,000.01		
ptd1yr_numacct_50kt100k	50,000.00 - 100,000.00	number of accounts	
ptd1yr_amt_50kt99k	50,000.00 - 100,000.01		**BSP Branch Regional Information System (BRIS)**
ptd1yr_numacct_100kt499k	100,000.01 - 500,000.00	number of accounts	
ptd1yr_amt_100kt499k	100,000.01 - 500,000.01		
ptd1yr_numacct_500ktob1m	500,000.01 - 1,000,000.00	number of accounts	
ptd1yr_amt_500ktob1m	500,000.01 - 1,000,000.01		
ptd1yr_numacct_over1m	1,000,000.01 AND ABOVE	number of accounts	
ptd1yr_amt_over1m	1,000,000.01 AND ABOVE		
		Peso Time Deposit, over 1 yr	
ptdover1yr_numacct_b50k	Below 50,000.00	number of accounts	
ptdover1yr_amt_b50k	Below 50,000.01		
ptdover1yr_numacct_50kt100k	50,000.00 - 100,000.00	number of accounts	
ptdover1yr_amt_50kt99k	50,000.00 - 100,000.01		
ptdover1yr_numacct_100kt499k	100,000.01 - 500,000.00	number of accounts	
ptdover1yr_amt_100kt499k	100,000.01 - 500,000.01		
ptdover1yr_numacct_500ktob1m	500,000.01 - 1,000,000.00	number of accounts	
ptdover1yr_amt_500ktob1m	500,000.01 - 1,000,000.01		
ptdover1yr_numacct_over1m	1,000,000.01 AND ABOVE	number of accounts	
ptdover1yr_amt_over1m	1,000,000.01 AND ABOVE		
		Peso Time Deposit	
ptd_numacct_b50k	Below 50,000.00	number of accounts	

Variable Code	Variable name	Remarks	Data Source
ptd_amt_b50k	Below 50,000.01		
ptd_numacct_50kt100k	50,000.00 - 100,000.00	number of accounts	
ptd_amt_50kt99k	50,000.00 - 100,000.01		
ptd_numacct_100kt499k	100,000.01 - 500,000.00	number of accounts	
ptd_amt_100kt499k	100,000.01 - 500,000.01		
ptd_numacct_500ktob1m	500,000.01 - 1,000,000.00	number of accounts	
ptd_amt_500ktob1m	500,000.01 - 1,000,000.01		
ptd_numacct_over1m	1,000,000.01 AND ABOVE	number of accounts	
ptd_amt_over1m	1,000,000.01 AND ABOVE		
rps_numacct		Regular Peso Savings number of accounts	**BSP Branch Regional Information System (BRIS)**
rps_amt		amount	
ln_rpsamt		natural log	
lnptd_amtb50k			
lnptd_amt50t99k			
lnptd_amt100kt499k			
lnptd_amt500kt1b			
lnptd_amtover1m			
rpsamt_gr		growth rate	
numbrprov			
id2r1			
rreg		new regional classification	
tloans_gr		growth rate	**BSP Department of Supervisory Analytics (DSA)**
tassets_gr		growth rate	
tdepliab_gr		growth rate	
tliab_gr		growth rate	
npl_gr		growth rate	
nplratio_gr		growth rate	
qgrdp_nomgr		growth rate	
qgrdp_realgr		growth rate	
totequity_gr		growth rate	
totintinc_gr		growth rate	
totintexp_gr		growth rate	
prov4losses_gr		growth rate	
netinc_gr		growth rate	
nonintinc_gr		growth rate	
nonintexp_gr		growth rate	
netprof_gr		growth rate	
lnrcv_gr		growth rate	
demand_gr		growth rate	
savings_gr		growth rate	
time_gr		growth rate	
now_gr		growth rate	

Variable Code	Variable name	Remarks	Data Source
ltncd_gr		growth rate	**BSP Department of Supervisory Analytics (DSA)**
ln_tdepliab		natural log	
operinc		operating income	
costinc		non-interest expense / operating income	
tdepliab1			
ln_tloans		natural log	
ln_netintinc		natural log	
ln_netprof		natural log	
ln_nonintexp		natural log	
ln_npl		natural log	
roa			
roe			
_merge			
eqty2assets			
tglenda_rr	typhoon glenda	obtained regulatory relief	
tluismar_rr	typhoon luismar	obtained regulatory relief	
truby_rr	typhoon ruby	obtained regulatory relief	
tseniang_rr	typhoon seniang	obtained regulatory relief	
tineng_rr	typhoon ineng	obtained regulatory relief	
tlando_rr	typhoon lando	obtained regulatory relief	
tlawin_rr	typhoon lawin	obtained regulatory relief	
tnina_rr	typhoon nina	obtained regulatory relief	
tmaring_rr	typhoon maring	obtained regulatory relief	
tjosie_rr	typhoon josie	obtained regulatory relief	
t2018q3q4			
regrelief	regulatory relief	number of times that regulatory relief was obtained	
d_regrelief		regulatory relief dummy	
maxrfall		maximum rainfall	**Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA)**
rfall_index		rainfall index	
rfall_index1	interacted rainfall variable	rfall x rfall lagged (-1)	
rfall_index2		rfall x rfall lagged (-2)	
rfall_index3		rfall x rfall lagged (-3)	
rfall_index4		rfall x rfall lagged (-4)	
rfall_L1		lagged (-1)	
rfall_L2		lagged (-2)	
rfall_L3		lagged (-3)	
rfall_L4		lagged (-4)	
qgrdp_nom		estimated nominal qrtly GRDP	**Philippine Statistics Authority (PSA)**
qgrdp_real		estimated real qrtly GRDP	

Source of data: Authors.

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