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

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*/ The usual institutional disclaimer applies

What this paper does

- Estimate impact of extreme rainfall episodes on Philippine banking sector performance from 2014 to 2018
- Construct regional quarterly rainfall damage index (RDI) based on data of 53 weather stations across the Philippines
- Compile regional quarterly branch-level bank indicators (deposits by type, total loans, non-performing loans, equity, profitability indicators) and macroeconomic indicators (regional Gross Domestic Product)
- Examine persistence of RDI shocks on regional branch-level bank and growth indicators
- Offer implications for BSP policy particularly on sustainable finance

What this paper does not do

- **Scope**
  - Macroeconomic, monetary policy and social impacts
  - Transition risk, or how the world will evolve towards a low carbon economy
  - Impact on prudential indicators - capital adequacy ratio (CAR), liquidity standards (liquidity coverage ratio, net stable funding ratio, minimum liquidity ratio and probability of default
  - Detailed impact on real sector (aggregate economy - investments, consumption, trade)

- **Technical details**
  - Full/complete equilibrium perspective
  - More robustness checks on some indicators (bank risk-taking activities, deposit generation)

Motivation fits into recent empirical research

- The Philippines consistently in one of the more vulnerable countries to natural hazard risk, climate change risk and natural disaster risk
- **Impact of natural disasters on banking sector performance**
  - Deposit withdrawals and dry up in non-deposit funding were main drivers of lending slowdown following extreme hurricane, not adverse shocks to profitability, loan defaults and bank capital (Brei et al 2019)
  - Following flooding in Pakistan, banks disproportionately reduced credit to new and less-educated borrowers (Choudhary and Jain 2017)
  - Natural disasters increase likelihood of bank defaults and depends on financial regulation, a country's financial and economic development, and the size and magnitude of the disaster (Klomp 2014)
  - El Niño related flooding in Peru resulted in large loan losses that caused lender to contract credit, hindering economic recovery (Collier 2014).
- **Studies on impact on the Philippine banking sector relatively scant**
  - Positive association between natural disasters and median bank deposit interest rates across bank branches (Campipi et al 2018)
  - This paper adds to empirical studies by constructing a rainfall damage index and estimating its impact on regional bank branch-level data
  - This is a first in the Philippines

Top 10 Countries with Natural Hazard and Climate Risk 1/

(Ranking 1 to 10; 1 means the most vulnerable)

Natural Hazard Risk	Climate Change Risk	UN Natural Disaster Risk
1 **Philippines**	1 Puerto Rico	1 Vanuatu
2 Japan	2 Honduras	2 Tonga
3 Bangladesh	3 Myanmar	3 **Philippines**
4 Myanmar	4 Haiti	4 Guatemala
5 China	5 **Philippines**	5 Bangladesh
6 Indonesia	6 Nicaragua	6 Solomon Islands
7 India	7 Bangladesh	7 Brunei Darussalam
8 Vietnam	8 Pakistan	8 Costa Rica
9 Pakistan	9 Vietnam	9 Cambodia
10 Mexico	10 Dominica	10 Papua New Guinea

Sources: INFORM Global Risk Index 2019; Global Climate Risk Index 2019; UN-World Risk Index.
1/ Natural Hazard Risk Index is based physical exposure to natural hazards (actual and relative); Climate Risk Index is based on to what extent countries and regions have been affected by impacts of weather-related loss events. UN Natural Disaster Risk Index is based on theNatural Disaster vulnerability, susceptibility, lack of coping capacities and lack of adaptive capacities.

Source of Table : IMF Philippine Mission Team Presentation, 18 Nov 2019, BSP

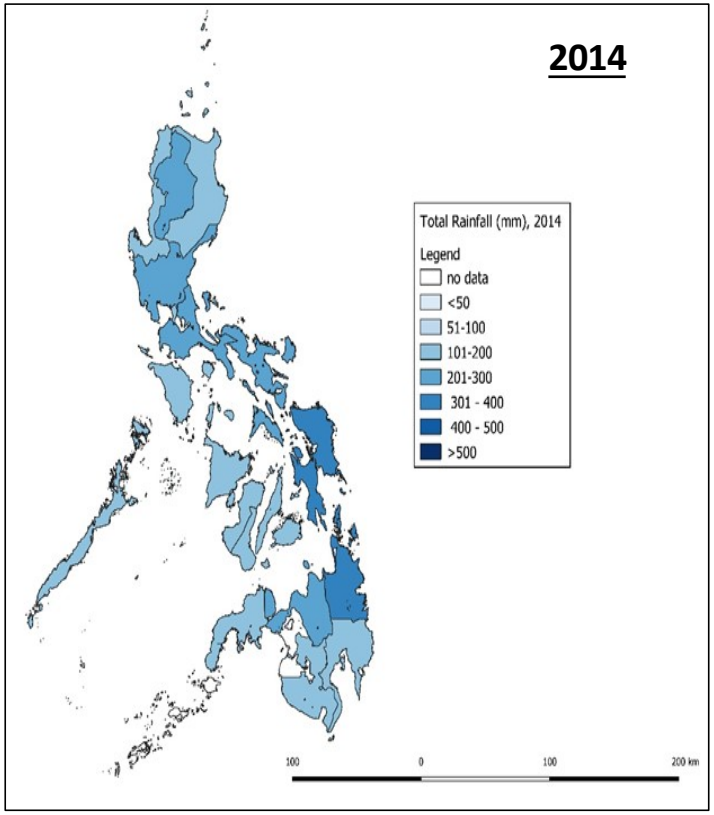
Preview of main findings

- Extreme rainfall episodes have negative impact on banking sector performance
- Deterioration in loan growth, asset quality, total assets and profitability, following significant withdrawal in deposits
- Negative impact seen larger in regular peso savings deposits
- Results are economically significant as impact seen in slowdown in regional GDP growth
- But, overall negative impact on total bank assets and profitability tapers off after two to three quarters

The rest of presentation

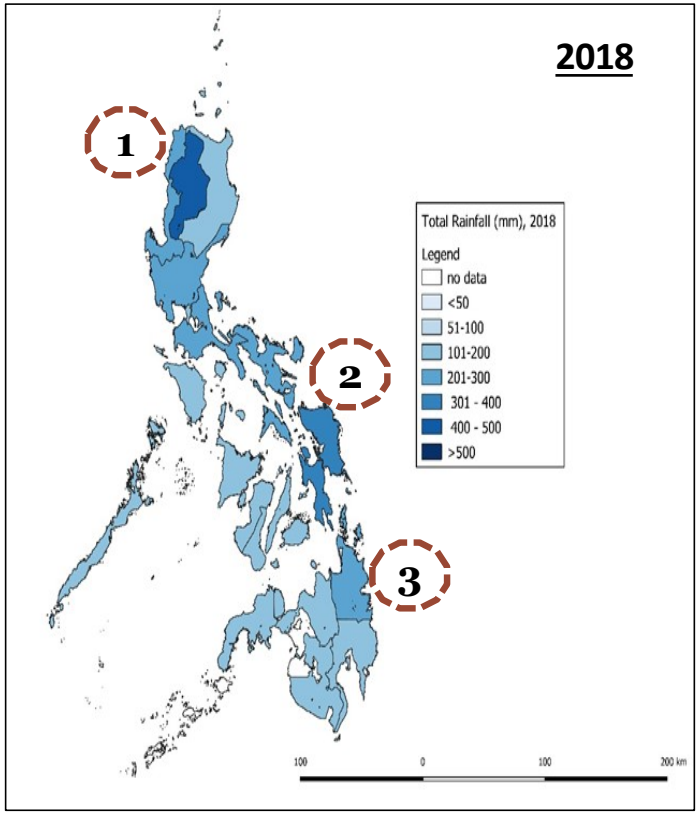
1. Database
2. Empirical model and estimation method
3. Robustness checks
4. Results
5. Conclusion – implications for BSP policy

1. Distinct changes in distribution and pattern of rainfall between 2014 and 2018 (1-5)



1. More provinces and regions prone to heavy rainfall in 2018 - Northern Luzon
2. Eastern Visayas remained as more susceptible to heaviest rainfall in 2018
3. Northern Mindanao less vulnerable to heavy rainfall in 2018

Source of data: PAGASA



1. A Rainfall Damage Index (RDI) for the Philippines (2-5)

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

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

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

where $\boldsymbol{V}$ is the actual rainfall amount for , $\boldsymbol{V_{thresh}}$ is the rainfall at and below which no damage occurs, and $\boldsymbol{V_{half}}$ is the rainfall amount at which half the property value is lost. $\boldsymbol{V_{thresh}}$ is obtained from climatological normal amount of rainfall in a month for each region as prescribed by PAGASA. $\boldsymbol{V_{half}}$ is computed as two standard deviation (based on historical amount of rainfall that produced massive flooding) above the climatological normal for each region

1. Branch-level bank-specific indicators (BRIS) (3-5)

Summary Statistics of Variables Used, March 2014-December 2018

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 30 days 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 1 year 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

- Quarterly data from Branch Regional Information System by municipality, province, region
- Data from 92,000 banking units
- Major funding source – total deposits classified by type, bucket size and by maturity (regular peso savings and peso time-savings deposits with less than 30 days, 1 year and over 1 year maturity)
- Loan and asset quality – total loans and non-performing loans
- Capital – total equity
- Profitability – net profit, net income, net interest expense, return on assets

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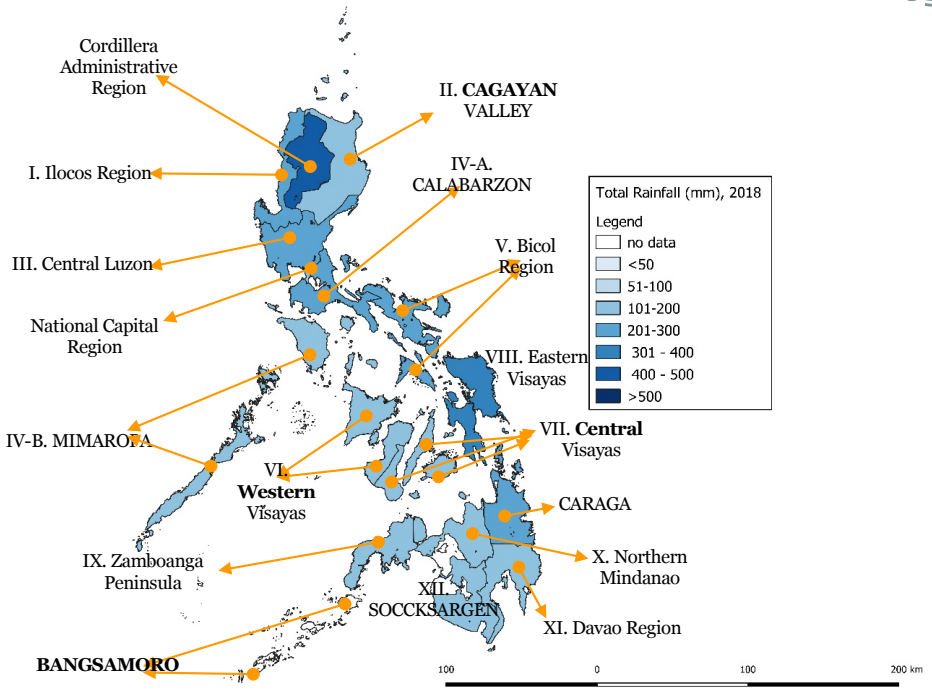
- More variation seen in total loans, total equity, total deposit liabilities, peso-time savings deposits with less than 30 days and over PhP 1 million, regular peso savings, net income
- Temporary regulatory relief given between 2014 and 2018 - 11 for damaging typhoons mostly in Visayas and Northern Luzon regions (BSP Circular 1017 in October 2018)

1. A Snapshot of the Analytical Framework (5-5)



Rainfall Damage Index (53 weather stations across municipalities/provinces/regions)

Quarterly Data

Regions	Avg. Rainfall (in mm)	Avg. Deposits (in Bil Pesos)	Avg. Loans (In Bil Pesos)	Avg. Net Profit (In Bil Pesos)
1-Ilocos Region	241.56	501.41	107.96	0.75
2- Cagayan Valley	165.77	412.56	181.72	0.90
3-Central Luzon	287.02	595.95	190.91	2.04
4A-CALABARZON	180.01	615.62	132.07	(1.56)
4B-MIMAROPA	228.41	456.97	146.55	4.26
5-Bicol Region	273.28	470.98	150.49	2.68
6-W. Visayas	176.33	608.81	167.48	(0.10)
7-C. Visayas	118.71	882.12	350.38	3.30
8-E. Visayas	355.67	640.85	168.25	2.72
9-Zamboanga	175.92	604.43	151.73	(0.78)
10-N. Mindanao	141.18	557.11	178.05	0.21
11-Davao Region	150.78	674.57	280.75	12.23
12-SOCCSARGEN	119.93	586.76	283.45	3.88
CAR	451.33	818.29	106.70	(2.02)
CARAGA	282.78	508.99	172.75	1.93
NCR	180.83	2,294.28	2,238.32	27.88

Branch-level banking sector quarterly data across municipalities/provinces/regions)

2. Empirical model and estimation method

- **Dynamic Panel GMM, March 2014-December 2018**

$$\boldsymbol{BankIndicators_{b,t}} = \boldsymbol{\alpha_{b,t}} + \sum_n^4 \boldsymbol{\beta_n RainIndex_{b,t-n}} + \sum_n^4 \boldsymbol{\beta_n RainIndex_b X\ RainIndex_{b,t-n}} + \boldsymbol{\varepsilon_{b,t}} \quad \textbf{, (eq. 3)}$$

where $\boldsymbol{BankIndicators_{b,t}}$ is a vector of bank variables of branch *b* at time *t* ; $\boldsymbol{RainIndex_{b,t}}$ is the constructed rainfall damage index per region which is applied to branch *b*, and $\boldsymbol{Rainfall\ X\ Rainfall_{t-n}}$, is the interacted variable of contemporaneous rainfall index with its lagged values.

- **Panel Structural VAR, March 2014-December 2018**

Cholesky ordering : $RainIndex_{b,t}$ ➡ $quarterly\ regional\ GDP\ growth_t$ ➡ $BankIndicators_{b,t}$

Shock from rainfall event is expected to affect ***production of agriculture and fisheries sector***, which in turn affects regional GDP growth. Regional GDP growth acts as a proxy for income and economic activity, which in turn, can affect bank performance.

3. Robustness checks

- Descriptive statistics checked for each variable used, including presence of outliers
- Coefficients significant at 5% and 10% (few runs) levels of significance
- Final regressions robust against different specifications of dependent and independent (levels vs growth)
- Different ordering of Structural Panel VAR used
- Alternative estimation method (Fixed Effect Model, Least Squares regression)
- Standard errors of regression, serial correlation and Hansen tests are checked

4. **Results** (1-3) : *Largely confirm other findings on impact of extreme weather conditions*

- Extreme rainfall episodes have direct negative impact on growth of total loans, total deposit liabilities, NPLs, net profit and return on assets, with lags
- Impact on growth of total loans appear to have the biggest negative impact
- Impact on growth in total deposits and ROA on a contemporaneous manner
- Impact on growth of equity not significant implies that bank capital remains strong against impact of extreme rainfall episodes

Table : Panel GMM Main Estimation Results , Q12014-Q42018

	Dependent Variable				
	DLOG (TLOANS)	DLOG (TDEPLIAB)	DLOG (NPL)	DLOG (NETPROF)	ROA
Explanatory Variables					
Dependent Variable(-1)	-0.003	-0.305	-0.197***	-0.506	-0.240***
RFALL_INDEX	0.330	-0.013**	0.033**	-0.080	-0.011*
RFALL_INDEX(-1)	0.240	-0.007	0.031**	-0.027	-0.017
RFALL_INDEX(-2)	0.510*	-0.008	0.068***	-0.10**	-0.016**
RFALL_INDEX(-3)	-0.346	0.019	-0.001	0.023	0.036
RFALL_INDEX(-4)	-0.551**	0.008	0.015	-0.125	0.039
RFALL x RFALL(-1)	0.011	0.000	-0.0004	-0.001***	0.001
RFALL x RFALL(-2)	-0.024***	0.001*	-0.002*	0.001	0.002
RFALL x RFALL(-3)	0.002	0.000	0.0001	-0.001	-0.001
RFALL x RFALL(-3)	0.020***	0.000	0.0003	0.002*	-0.002*
Observations	61,704	92,499	37,256	17,744	92,282
Period	2015Q4-2018Q4	2015Q4-2018Q4	2015Q4-2018Q4	2015Q4-2018Q4	2015Q4-2018Q4
Arellano-Bond serial correlation test	0.012	0.029	0.388	0.493	0.050
Hansen test	0.516	0.185	0.444	0.384	0.896

*Legend: * p<.05; ** p<.01; *** p<.001. Source of estimates: Authors*

4. Results (2-3): *Results robust against alternative estimation method*

- Results are consistently robust using fixed effects regression
- Extreme rainfall episodes have direct negative impact on main types of deposits- regular peso savings (larger impact) and peso time deposits across maturity

Table: Results of Fixed Effects Estimation

	Dependent Variable/s (DV)							
	DLOG (Deposit Liabilities)	DLOG (Total Loans)	DLOG (Net Interest Income)	DLOG (Net Profit)	DLOG (Non-Interest Expense)	DLOG (NPL)	ROA	DLOG (Operating Income)
DV (-1)	0.0453***	0.0205***	0.0657***	0.0832***	-0.0659***	0.0318**	-0.0284***	0.0376***
rfall_index	-0.0002***	0.0000	-0.0005	0.0001	0.0032***	-0.0003	-0.0001	-0.0003
rfall_index (-1)	-0.0002***	-0.0005*	0.0035***	0.0037***	0.0048***	-0.0002	-0.0003**	0.0031***
rfall_index (-2)	-0.0002***	0.0011***	-0.0015***	-0.0016***	0.0005***	-0.0010**	-0.0003*	-0.0013***
rfall_index (-3)	-0.0002***	0.0011***	0.0081***	0.0066***	0.0107***	-0.0001	0.0000	0.0083***
rfall_index (-4)	-0.0001***	0.0004	-0.0066***	-0.0063***	-0.0050***	-0.0003	-0.0001	-0.0053***
rfall_L1	0.0000	0.0000***	-0.0001***	-0.0002***	-0.0002***	0.0000	0.0000	-0.0001***
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**	-0.0001***	0.0000	0.0000	-0.0000***
rfall_L4	0.0000	0.0000**	0.0001***	0.0000***	0.0001***	0.0000	0.0000	0.0001***
N	102731	71123	35815	23235	102132	43697	102640	53598
F	19.52	14.06	430.4	150.4	999.1	1.716	4.253	346.1
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0798	0.0000	0.0000
r2_a	0.001	0.00097	0.08091	0.0522	0.06457	0.000073	0.000004	0.04538

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

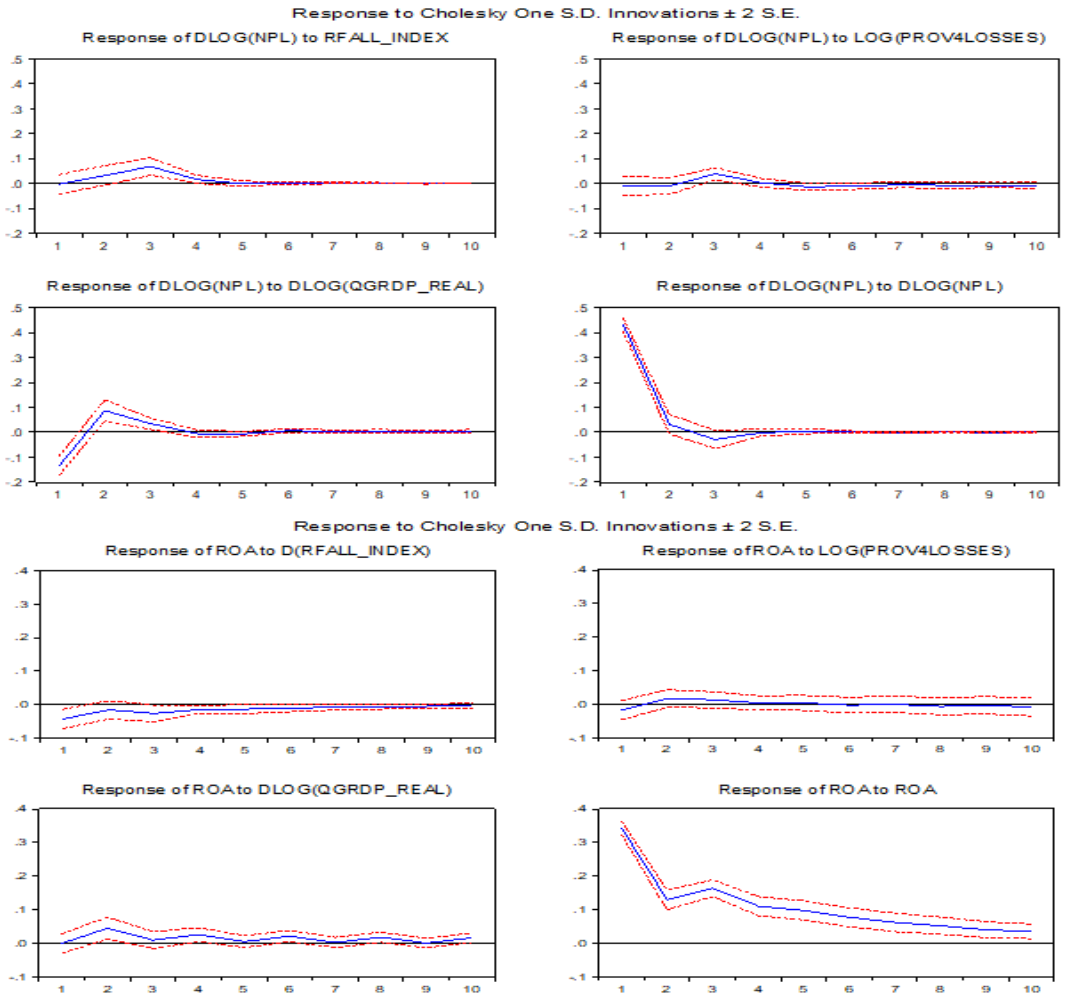
Variable	DLOG (Regular Peso Savings)
rfall_index	-0.001***
rfall_index1	0.001***
rfall_index2	-0.001***
rfall_index3	0.0000
rfall_index4	0.0000
rfall_L1	-0.000***
rfall_L2	0.000***
rfall_L3	0.0000
rfall_L4	0.000***
_cons	0.052***

*Legend: * p<.1; ** p<.05; *** p<.01*

4. **Results** *are economically significant* (3-3)

- Shocks to rainfall damage index have negative impact on regional GDP growth, possibly through losses in agriculture and fisheries production
- Shocks show deterioration in loan growth and asset quality as deposit liabilities contract and NPLs surge
- Overall negative impact on bank assets and profitability indicators eventually tapers off after two to three quarters

Figure: Impulse response of bank variables from rainfall shocks



Source of Panel VAR runs: Authors.

5. Conclusion: Implications for BSP policy (1-3)

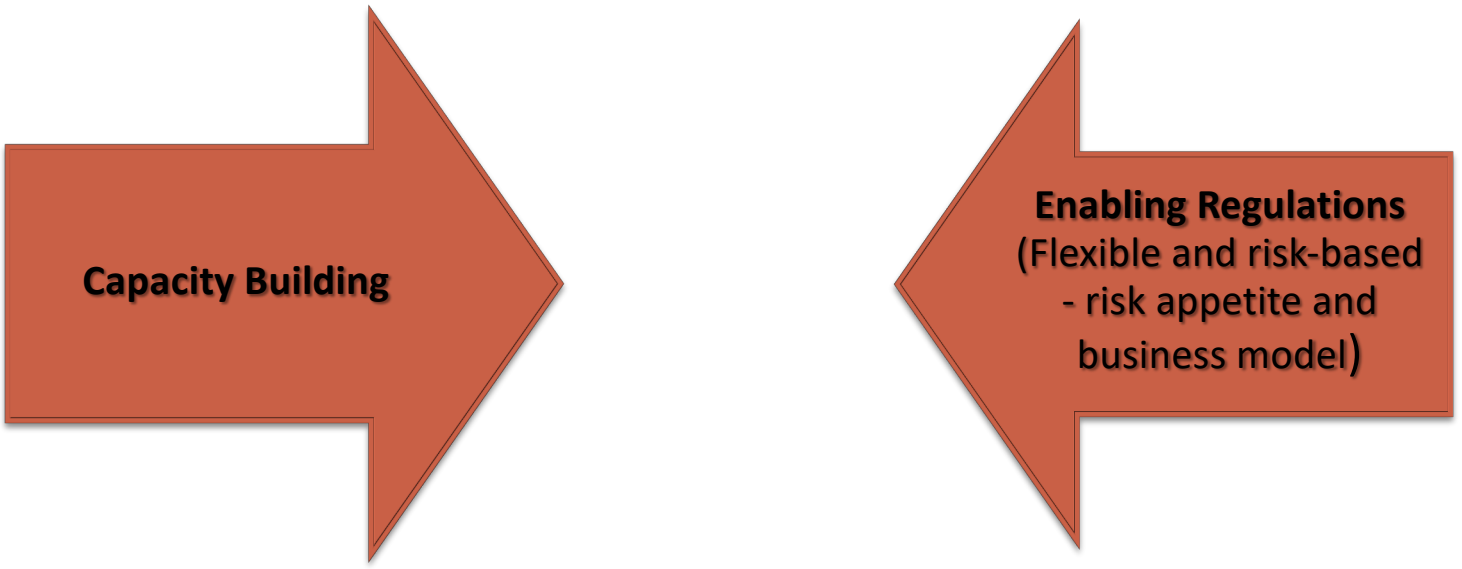
- Shocks on extreme weather episodes have compelling impact on Philippine banking sector performance
  - Microprudential policy – integrating climate and environmental risks into on-site examination, off-site monitoring and supervisory rating system crucially important
  - Macroprudential policy - inclusion of climate and environmental risks into stress testing exercise (both bank-level and industry) is useful
  - Comprehensive data needs have to be determined for Climate/Environmental Risk Analysis (borrower-level data, loan by industry)

- Underpinning BSP policies and regulations seem useful
  - As shocks from extreme rainfall episodes to bank total assets and profitability taper off and bank equity remains strong
  - BSP temporary relief policy formalized in 2018
  - Corporate Governance and Risk Management Guidelines (credit and operational risks)

- Importantly, a whole-of-government approach is necessary to strengthen green/sustainable finance
  - Joint BSP and Department of Finance set up of Inter-government agency Committee on Sustainable Finance
  - PH banks implementing sustainability principles in ESG even without explicit guidelines and issuing bonds
  - BSP investment in BIS green bonds (international reserves)
  - BSP to issue sustainable finance framework in phases

5. Conclusion: Implications for BSP policy (2-3)

BSP Approach to Sustainable Finance



5. Conclusion: Implications for BSP policy (3-3)

Enabling Regulations on Sustainable Finance

First	Second	Third
• Board and Senior Management Responsibilities • Risk Management System • Disclosure	• Guidance on major risks areas: credit, market, operational, reputational, among others	• Potential Regulatory Incentives

Muchas Gracias!

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